He that Veiws Forbes Face, sees but a R
Of light reflected, or a glymyse of day
But he that reads his Arras woven Lin
Contemplates Phæbus as he brightly shin

He that Veiws Forbes Face, sees but a R
Of light reflected, or a glymyse of day
But he that reads his Arras woven Lin
Contemplates Phæbus as he brightly shin

THE WHOLE BODY OF ARITHMETICK Made Easie:

Wherein

The Rules of that Art are briefly explained and Illustrated with such familiar Examples as may reach the Capacity of any that desire to learn it.

By *A. Forbes*. Philomat.

Praestat multa paucis, quam pauca multis Scribere.

LONDON,
Printed by *J. B.* for *Dorman Newman* at the Kings Arms in the Poultrey, 1676.

8°Z. 9. Art.

Imprimatur,

Aug. 1. *Roger L'Estrange*

To the Honourable

Sir *James Langham*, Baronet

SIR,

YOur Great vertue, the great affection you bear towards all Learning, and the Lovers of it, together with my Duty, have encouraged me to be thus bold to prefix your Name to this small Tractate, and to offer it up unto you, as a present of the first-fruits of my studies, in testimony of my dutiful gratitude for great and undeserved favours, bestowed on,

Sir,

Your most humble

and most obliged servant,

Al. Forbes.

To the Reader.

MY designe was to present the Publick with a small Tractate of Arithmetick, that might contain all the Rules of that art explained in a familiar way to any Learners Capacity, so as he might not be discouraged either by Prolixity or obscurity, which (no doubt) has been the designe of Learned and Ingenious Writers of this Subject, but none is allowed to have accomplished the design, some being too Voluminous, some too obscure, and others have left out necessary Rules to contract the bulk; and none have in so small a Volumne so plainly delivered all the Rules of Vulgar Arithmetick : *But whether or no this Tractate answers the designe, I leave thee to judge, hoping thou wilt judge impartially.*

Farewell.

THE CONTENTS OF THE BOOK.

Chap. I.

Concerning *Notation of Numbers, with a Table of Numeration.* pag. 1.

Chap. II. *Addition, of Money, Weight and Measure,* &c. pag. 4.

Chap. III. *Substraction of Money, weight,* &c. pag. 9.

Chap. IV. *Multiplication.* pag. 14.

Chap. V. *Division.* pag. 19.

Chap. VI. *Reduction.* pag. 29.

Chap. VII.

Chap. VII. *Notation of Vulgar fractions.* pag. 34

Chap. VIII. *Reduction of Vulgar fractions.* pag. 36.

Chap. IX. *Addition of Vulgar fractions.* pag. 42.

Chap. X. *Substraction of Vulgar fractions.* pag. 44.

Chap. XI. *Multiplication of Vulgar fractions,* pag. 47.

Chap. XII. *Division of Vulgar fractions.* pag. 49.

Chap. XIII. *The Rule of 3 in whole Numbers.* pag. 51.

Chap. XIV. *The Rule of 3 in fractions, with the Rules of practice by Aliquote parts and brief ways for computing Allowances of Tare and Tret.* pag. 59, 65, 74, 80.

Chap. XV. *The double Rule of 3, and the Compound Rule of 5 Numbers.* pag. 84.

Chap. XVI. *Of Exchange of Coins, weights, and Measures.* pag. 93.

Chap. XVII. *Of Barter.* pag. 101.

Chap. XVIII.

Chap. XVIII. *Of Factorſhip.* pag. 102.
Chap. XIX. *The Rule of Fellowſhip with and without time.* pag. 103.
Chap. XX. *The Rule of Alligation Medial and Alternate.* pag. 112.
Chap. XXI. *The Rule of Falſe of ſingle and double poſition.* pag. 121.
Chap. XXII. *Notation of decimal fractions.* pag. 130.
Chap. XXIII. *Addition and ſubtraction of decimal Fractions.* pag. 133.
Chap. XXIV. *Multiplication.* pag. 134.
Chap. XXV. *Diviſion.* pag. 136.
Chap. XXVI. *Reduction of Common fractions to decimal fractions.* pag. 139.
Chap. XXVII. *Reduction of decimal fractions to Common fractions.* pag. 141.
Chap. XXVIII. *Of ſimple Intereſt.* pag. 143.
Chap. XXIX. *Of Compound Intereſt, with a table.* pag. 147.
Chap. XXX. *Of Rebate or diſcount with tables.* pag. 152.

Chap.

Chap. XXXI. *Concerning Annuities the summing of them up when in arrear and the finding the present values of Annuities that are to continue for certain years.* &c. pag. 58

Chap. XXXII. *Of Equation of payments.* pag. 176

Chap. XXXIII. *Of Loss and Gain,* pag. 180

Chap. XXXIV. *Of Arithmetical progression,* pag. 184

Chap. XXXV. *Of Geometrical progression.* pag. 193

Chap. XXXVI. *The Extraction of the square root.* pag. 199

Concerning

CHAP. I.

...cerning Notation of Numbers.

ARithmetick is the Art of Numbring well.

A Number is that according to which any thing is Num-...d.

...ll Numbers are expreſt by theſe Characters or figures following, ...ſe ſimple value you may ſee ſu-ſcribed,

...wo, three, four, five, ſix, ſeven, eight, nine.

2 3 4 5 6 7 8 9

...lotation teacheth to expreſs or de-...e the value of, or to write down number propounded, with pro-Characters in their due places; for attaining whereof obſerve.

. That in every Number there are ...nany places as there are Figures.

Chap. XXXI. *Concerning Annuit*
the summing of them up when in arr
and the finding the present values
Annuities that are to continue for c
tain years. &c. pag.
Chap. XXXII. *Of Equation of p*
ments. pag. 1
Chap. XXXIII. *Of Loss and Gain,* pa
1
Chap. XXXIV. *Of Arithmetical p*
gression, pag. 1
Chap. XXXV. *Of Geometrical p*
gression. pag. 19
Chap. XXXVI. *The Extraction of th*
square root. pag. 19

Concerning

CHAP. I.

Concerning Notation of Numbers.

ARithmetick is the Art of Numbring well.

Number is that according to which any thing is Numbred.

All Numbers are expreſt by theſe ten Characters or figures following, whoſe ſimple value you may ſee ſuperſcribed,

one, two, three, four, five, ſix, ſeven, eight, nine.

1 2 3 4 5 6 7 8 9

Notation teacheth to expreſs or declare the value of, or to write down any number propounded, with proper Characters in their due places; for the attaining whereof obſerve.

1. That in every Number there are ſo many places as there are Figures.

2. The order of the places is from the right hand to the left, so the outermost figure towards the right hand is in the first place, and the outermost towards the left hand is in the last place.

3. The places proceed in a decuple or tenfold proportion, the first place is the place of Units, wherein a figure betokeneth its own simple value; the second is the place of tenns, wherein a figure signifieth ten times its own value; the third is the place of hundreds, wherein any figure signifieth a hundred times its simple value, or so many hundreds; thus you may express 666, six hundred sixty and six: the values of the other places you may see in the following table.

The Table of Numeration.

Left hand.	4. period. Mill. of Mill.			3. period. Millions			2. period Thousands.			1. period lds yds or &c.			Right hand.
	C.	X.	U.	C.	X.	U.	C.	X.	U.	hund.	Tens	Units	
	9	6	8	5	4	3	6	7	8	4	4	4	
	5	0	0	4	0	0	0	6	0	0	5	0	

By the help of this preceding Table and the directions already given, you may expreſs any any number whatſoever: thus.

Let 8886649 be to be expreſs'd. divide it into periods, by beginning at the right hand and cutting off 3 figures with a comma or point, as in this example,---8, 886, 649--then beginning at the left hand, pronounce each period diſtinctly by it ſelf (according to the former directions) adding thereunto its name which you ſee ſet over in the table, ſo will the number be thus read, 8 millions, 8 hundred eighty ſix thouſand, ſix hundred forty nine, and thus you may expreſs

any other number bigger or leſſer.

If it be required to write down any number, then write down the figures, expreſſing the value of the number in their due places, and for every intermediate place that is wanting you muſt put a cipher; ſo will 30 millions 60 thouſand and ſix, be thus expreſſed in Characters, *viz.* 30. 060. 006. And thus you may write down any other number.

CHAP. II.

Addition.

ADdition teacheth to gather diverſe Numbers into one ſum, total or aggregate.

If the Numbers given to be added are of one name, then rank them orderly as in the example following.

9	6	8	4	6	*l.*
5	3	9	3	4	
8	5	3	4	5	
8	6	5	3	8	
32	26	63			

Then

Then beginning at the right hand, add up the first rank, saying 8, 5, 4 and 6 make 23, write down all above ten or tens, *viz.* 3. and bear the number of tenns in minde to be added to the next rank, thus, 2, 3, 4, 3 and 4 make 16, write down 6 and bear 1 in minde, and say, 1, 5, 3, 9 and 8 makes 26, write down 6 and bear two in minde, and say 2, 6, 5, 3 and 6 make 22; write down 2, and say 2, 8, 8, 5 and 9 make 32; which write down, there being no place remaining, so the total or sum is 322663——

If the numbers to be added are of divers denominations, as pounds, shillings, and pence, *&c.* then write them down, so as numbers of one name may be orderly under one another, and that the least name be next the right hand; as in the example following.

l.	*s.*	*d.*	*f.*
4368	18	11	3
9731	17	10	2
8653	19	09	1
9763	14	08	3
3421	15	07	3
8681	10	09	1
9321	16	11	2
53943	14	08	3

Then minde the title of your account, and see how many of each lesser name makes one of the next greater, then beginning with the least name, first add up the numbers as they stand, putting a point or mark where they amount to so many as make one of the next greater name, (as in reckoning of pence you point at every 12*d*) and if there be any over and above, these you must write down directly underneath the numbers; then see how many of the greater named were in that sum (which you may easily finde by reckoning the number of your points) and add so many to the next greater name, which you.

you must add up in the same manner as you did the lesser name, and thus proceed till you come to the greatest name which you add up, as is taught in the beginning of this Chapter.

Thus in example, I point at every 12*d* in reckoning the pence, and at every 20*s* in reckoning the shillings, and so at last finde the sum to be 53943*l*.--14*s*.--8*d*.--3*f*.

The proof of Addition.

l.	*s.*	*d.*	*f.*
4368	18	11	3
9331	17	10	2
8653	19	09	1
9763	14	08	3
8421	15	07	3
8681	10	09	1
9321	16	11	1
53943	14	08	3
49574	15	09	0
53943	14	08	3

Cut off with your pen the first line of your Addition, then add up all the

other lines again, lastly to the last sum add the line cut off, and if the sum be equal to the first sum the work is true, if unequal, the work is false.

More examples of Addition.

Note, 4 nails make one quarter of a yard, and 4 quarters a yard.

yds	*qu.*	*nails*
366	2	3
586	2	1
864	3	2
973	2	3
856	3	2
3648	3	3
3282	0	0
3648	3	3

Note, 40 perches make one rood, and 4 rood one Acre.

acres	*roods*	*perches*
9648	3	29
8964	2	36
4289	3	39
6848	2	28
9656	3	28
39409	1	00
29760	1	11
39409	1	00

And thus you may add numbers of any names or denominations.

CHAP. III.

CHAP. III.

Subſtraction.

SUbſtraction teacheth to take one number out of another, ſo that the remainder or difference may be known.

If the numbers given be of one name, then write down firſt the greater and under it the leſſer, then beginning at the right hand, ſubſtract the firſt figure of the leſſer number, out of the firſt figure of the greater number, and write down the remainder or difference directly under them, then proceed to the next figure of the leſſer number and ſubſtract it (if it can be done) from the ſecond of the upper number, noting the difference as before, and thus proceed with all the figures till the ſubſtraction be ended, and then you'l have the whole remainder.

l.	
8968	*debt*
7253	*paid*
1715	*Reſts*

But if any figure of the lower number be greater than the figure of the upper number that ſtands over it, you muſt increaſe the leſſer figure by ten, and then ſubſtract as before, and for the ten added you muſt add one to the following figure of the lower number, and then proceed as is taught, as in this example:

3609 *l.*
3987
2622

Subſtraction of numbers of divers names.

Rank the numbers as in Addition, and beginning with the numbers of the leaſt denomination, ſubſtract the lower from the upper number, noting down the remainder as before, & thus ſubſtract the other denominations one from another if it can be done, as in this example.

l.	*s.*	*d*
868	18	10
498	16	08
370	2	2

But

But if the upper number of any denomination be lesse than the lower number of the same denomination, then you must borrow one from the next greater name, and substract the lower number from it, and the upper number put together, noting the remainder as before; and for the one borrowd, you must add one to the lower number of the next greater name, and proceed as is taught.

l.	*s.*	*d.*
845	11	09
598	19	11
246	11	10

If there be 2, 3 or more numbers to be substracted from one; you may first add them together, and then substract their sum from the number given, or briefly thus. Having rank'd the

l.
9764
5348
2798
1628

numbers orderly, first substract the sum of each rank severally from the figure that stands over it, borrowing so many

many tenns (if the numbers be of one name) or so many integers from the next greater name (if of several names) noting the remainder and the number of tens or integers borrowed; you must add to the Rank following, and proceed as before to the end of the substraction: as for example.

l.	*s.*	*d.*
82	7	9
30	8	7
48	9	8
36	7	9
67	1	9

The proof of Substraction.

Add the remainder to the lower number or numbers, and if their sum make the upper number your work is true, otherwise false. *Note*, that by the upper number, I mean the number from whence the number or numbers given are to be substracted.

Example

Examples of Substraction.

yds	*qu.*	*nails*
836		3
239	3	2
386	1	3
198	3	2
11	3	0
836	3	3

l.	*s.*	*d*
86	9	11
48	8	10
29	7	11
08	9	10
0	3	04
86	9	11

acres	*roods*	*perches*
966	3	29
598	3	38
079	2	34
86	3	28
98	3	36
8	3	34
1	9	36
81	2	23
966	3	29

proof.

CHAP.

CHAP. IV.

Multiplication.

MUltiplication teacheth by two given numbers to find a third, which will contain either of the given numbers, so oft as the other contains 1 or unity.

The greater of the given numbers is called the Multiplicand, and the lesser is the Multiplier.

The third number fought, or arising by the multiplication of the other two is called the product.

1	2	3	4	5	6	7	8	9
2	4	6	8	10	12	14	16	18
3	6	9	12	15	18	21	24	27
4	8	12	16	20	24	28	32	36
5	10	15	20	25	30	35	40	45
6	12	18	24	30	36	42	48	54
7	14	21	28	35	42	49	56	63
8	16	24	32	40	48	56	64	72
9	18	27	36	45	54	63	72	81

It is neceſſary that the learner have by heart the ſeveral varietie of the multiplications of the nine figures, expreſt in this table; for the underſtanding of which ſuppoſe you would know what is 8 times 9, ſeek 8 in the upper part of the table, and 9 in the ſide, and under the one, and oppoſit to the other, youl ſee 72. and thus youl finde 7 times 8 to be 56, *&c.*

When the Multiplicand conſiſts of more figures than one, and the multiplyer is a ſingle figure, as 364 by 6, then write them down orderly, as in this Example.

Multiplicand	364
Multiplier	6
	2184

Multiply every figure of the Multiplicand by the multiplier, ſetting down all under or above ten, or tenns, and for every ten carrying one to the next place, till you come to the laſt place where you ſet all down: thus: ——6 times 4 is 24. I ſet down 4 and carry 2; then 6 times 6 is 36, and 2 is 38. I ſet down 8 and carry 3. then 6 times

times 3 is 18, and 3 is 21 I, set down 21. so the product is 2184.

When both the Multiplicand and Multiplier consists of 2, 3 or more figures, place them orderly under one another thus:—

```
   3654
    236
  -----
  21924
 10962
 7308
 -------
 862344
```

Then multiply every figure of the Multiplicand by 6, the first figure of the multiplier as before: then cancelling 6 with a dash of your pen, multiply by the other two figures of the multiplier, to wit, 3 and 2 severally, as is already taught, observing to set down the first figure of each product under the respective multiplying figure, so being to multiply by 3, I say 3 times 4 is 12, and set down the 2 under the 3, and then I proceed as before. Again, multiplying by 2, I say, 2 times 4 is 8, and set down the

8

8 under the 2. and then proceed as is taught. Laſtly, I add up the 3 products as they ſtand, and the ſum gives the total product, *viz.* 862344.

According to this method you may multiply any two numbers you propoſe.

How to Multiply by 10. 100. 1000, &c.

To your multiplicand add ſo many ciphers as there are in your multiplier the whole is your product, thus, 48 by 10. is 480. and 66 by 1000 is 66000.

How to Multiply by 20 30. 400, &c.

Multiply by the figures 2, 3, or 4, &c. and to the product add the ciphers thus: 64 by 20 is 1280. and

99	64
5000	900
495000	57600

The

The proof of Multiplication.

To prove the former example, out of the multiplicand 3654 cast away the nines thus; 3 and 6 is 9, rests 0, and 5 and 4 is 9 rests 0, which set down at 0 X 0 the side of a cross thus: then 2 X 0 cast away the nine out of the multiplier, saying 2, 3 and 6 make 11, rests 2 above 9, which set down at the lower end of the cross under 9, and multiply the one by the other, casting out the nines out of that product, as before; thus 2 times 0 is 0, which place opposit to the first 0, on the other side of the cross: lastly cast away the nines out of the product, saying 8 and 6 is 14 rests 5 above 9, and 5 and 2 is 7, and 3 is 10, rests 1 above 9. then 1 and 4 and 4 makes 9, rests 0, which set at the other end of the cross, then because the upper and the lower figure are alike you may judge your work to be true.

Though this be the common way of proving Multiplication, yet it's fallible, and the surest proof is Division.

Example

Examples of Multiplication.

If 1 *l.* of Tobacco coſt 48 *d.* what will 9368 *l.* coſt.

9268 *l.*
48
74944
37472
449664 *d.*

3986 *yds.*
at 368 *d-yd.*
31888
23916
11958
1466848 *d.*

CHAP. V.

Diviſion.

DIviſion teacheth to finde how oft one number is contained in another.

The number given to be divided is called the dividend.

The number by which it is to be divided is called the diviſor.

The number ariſing from the diviſion is called the quotient, becauſe it denotes

notes *quoties*, or how often the diviſor is contained in the dividend.

If 886*l.* were to be divided amongſt 6 men, place the dividend 886 and the diviſor 6 orderly under one another, as in this example, unleſs the dividing figure be greater than the firſt figure of the dividend, for then it muſt ſtand under the ſecond figure of the dividend, for you muſt always obſerve, ſo to place your diviſor, that the number of the dividend that ſtands over it may be greater, or at leaſt equal to it: this done obſerve theſe directions.

886 (
6

1. Seek how oft your diviſor is contained in your dividend, and write the number of times in the quotient.

2. Multiply the diviſor by the quotient.

3. Subſtract that product orderly from the figures of the dividend that ſtands over the diviſor, noting the remainder above the reſpective figures.

This done remove your diviſor a place further towards the right hand and proceed as before, continuing the

ſame

same work to the end of the division.

These directions will be cleared by the following examples.

In the first example, I seek how oft 6 in 8. I find it once, I write 1 in the quotient, and say, once 6 is 6 from 6 rests 2, which I write above 8, cancelling 6 and 8 with my pen.

2
886 (1
6

Then I remove my divisor a place further, and seek how oft 6 in 28, I finde it 4. wherefore I put 4 in my quotient, and say 4 times 6 is 24, from 28 rests 4, which I place above 8. cancelling 2 6 and 8 as before.

24
886 (14
66

Again I remove my divisor a place further, and seek how oft 6 in 46, which being found 7 times, I place 7 in my quotient, and say 7 times 6 is 42, from 46 rests, 4 which I place above 6, cancelling 6, 6 and 4 as before, and the division is ended, so the quotient denotes that each man must have 147 *l.*

24 (4
886 (147
666

and

and a fraction whereof we shall treat hereafter.

If in dividing it happen that you cannot substract the divisor from the number that stands over it, then you must write a cipher in your quotient, and remove your divisor a place further, and divide as before.

Example.

If 3632*l.* were to be divided into 4 parts; first I place them orderly under one another, then I seek how oft 4 in 36, and finde it 9 times, I put 9 in the quotient, and say 9 times 4 is 36, from 36 rests 0, which (cancelling 3 6 and 4) I place above 6; then I remove my divisor a place further, and seek how oft 4 in 3, which I finde not once, wherefore I put 0 in the quotient, and remove the divisor a place further, and seek how oft 4 in 32, which I find 8 times, wherefore I put 8 in the quotient, and say 8 times 4 is 32, from 32 rests 0, so is the division ended.

```
  0  0
3632 (908
444
```

When the divisor consists of more figures than one, then in your asking the

the queſtion, how oft the diviſor is contained in the dividend, you begin with the firſt figure of the diviſor towards the left hand, & ſeek how oft it is contained in the figure or figures of the dividend that ſtand over it, but you muſt take it no oftner than you can have all the other figures of the diviſor in the figures of the dividend that ſtand over them: Then multiply the figures of the diviſor, orderly, by the quotient found, and ſubſtract their particular products, from the figures that ſtand over them, borrowing ſo many tens as you need, and adding the number of tens borrowed to the product of the following figure of the diviſor, being multiplied by the quotient, ſubſtracting as before, and write the particular remainders over the reſpective figures of the dividend, and cancel every figure of the diviſor ſo ſoon as you have multiplied it, and every figure of the dividend when you have made the ſubſtraction from it.

Then remove your diviſor a place further, and repeat the ſame work to the

the end of the division, observing the former directions.

An example of division by two figures.

172869 by 36

```
 28
~~1~~ ~~7~~ ~~2~~ 8 6 9 (4
 ~~3~~ ~~6~~
```

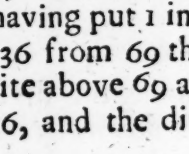
I place them as in the margin, then I ask how oft 3 in 17, and finde it 5 times, and there will remain 2, but I have 6, 5 times in 22; wherefore I must take it but 4 times; I put 4 in the quotient, and say 4 times 6 is 24, from 2 I cannot, but I borrow 3 tenns and so it is 32 and there remains 8, which I write above 2, cancelling 2 and 6: then 4 times 3 is 12, and the 3 tenns I borrowd makes 15, from 17 rests 2, which I write above 7, cancelling 71 and 3.

```
  0
 ~~2~~ ~~8~~ 0
~~1~~ ~~7~~ ~~2~~ ~~8~~ 6 9 (48
 ~~3~~ ~~6~~ ~~6~~
  ~~3~~
```

Then I remove the divisor a place further, and seek how oft 3 in 28, I finde it 9 times, but cannot take it, having

having reſpect to 6, I take it eight times and put 8 in my quotient, and ſay 8 times 6 it 48 from 48 reſts 0, which I write above 8, then 8 times 3 is 24 and 4 borrowed is 28 from 28 reſts 0, which needs not be written down, I cancel the figures 3 6 8 2 8 as is taught.

Then removing the diviſor a place further I finde 3 in 0 wherefore I put (as is directed) 0 in the quotient and remove the diviſor a place further, and ſeek how oft 3 in 6, I finde it twice but cannot take it, for twice 6 cannot be had in 9, wherefore I take it but once, and having put 1 in the quotient I ſubſtract 36 from 69 there reſts 33, which I write above 69 and cancel the figures 6936, and the diviſion is ended.



An example of division by 3 figures.

36788 *l.* amongst 348 men, place them thus,

```
      9
  36788 ( 1
  348
```

I finde 3 in 3 once, I put 1 in the quotient, and substract 348 from 367 writing the remainder as is already directed, having canceld the divisor and such part of the dividend as stand over it.

```
      19
  36788 ( 10
  34888
   344
     3
```

Then removing the divisor a place further, I ask how oft 3 in 1 and no finding it once I put 0 in the quotient & remove the divisor a place further and seek how oft 3 in 19, I finde it 6 times, but it will not hold; I take therefore 5, times, and having put 5 in the quotient, say 5 times 8 is 40 from 48 rests 8, which I place above 8, and 5 times 4 is 20, and 4 is 24 from 28 rests 4, which I put above 8

last

lastly 5 times 3 is 15, and 2 is 17, from 19, rests 2, which I place above 9, so is the division finished.

```
      (2
      1 9(4
3 6 7 8(8 (105
3 4 8 8 8
  3 4 4
    3
```

An example of division by 4 figures.

367896 *l.* to be divided amongst 3868 soldiers: place the numbers as follows.

```
  1977
3 6 7 8 9 6 (9
  3 8 6 8
```

First, I seek how oft 3 in 36, I finde it to hold 9 times, wherefore I put 9 in the quotient, and say, 9 times 8 is 72, from 79 rests 7, which *I* place above 9; then 9 times 6 is 54, and 7 is 61, from 68 rests 7, which *I* write above 8; and 9 times 8 is 72, and 6 *I* borrowed is 78, from 87 rests 9, which *I* write above 7. Lastly, 9 times 3 is 27, and 8 *I* borrowed is 35, from 36 rests 1, which *I* put above 6, and can-

cel the divisor and dividend, as before is taught.

```
          (4 3
    ~~1~~ ~~9~~ ~~7~~ ~~7~~ (6
~~3~~ ~~6~~ ~~7~~ ~~8~~ ~~9~~ ~~6~~ (95
    ~~3~~ ~~8~~ ~~6~~ ~~8~~ ~~8~~
        ~~3~~ ~~8~~ ~~6~~
```

Then *I* remove the divisor a place further, and ask, how oft 3 in 19, *I* finde, it 6 times, but the other figures will not hold; wherefore *I* take it 5 times, & having put 5 in the quotient, *I* say 5 times 8 is 40, from 46 rests 6, which *I* place above 6, then 5 times 6 is 30, and 4 *I* borrowed is 34, from 37 rests 3, which *I* place above 7, then 5 times 8 is 40, and 3 is 43, from 47 rests 4, which *I* place above 7; Lastly, 5 times 3 is 15, and 4 *I* borrowed is 19, from 19 rests 0: so having cancelled the figures, as is taught, and separated the remainder, the work is done.

According to this method you may divide any greater number by 5, 6, 7. or more figures.

Example.

Example.

898684568 *by* 7896589

```
(63900
 3 0 0 5 9 7(1
 1 0 9 0 2 5 6 7(1
 8 9 8 6 8 4 5 6 8 (113
 7 8 9 6 5 8 9 9 9
   7 8 9 6 5 8 8
     7 8 9 6 5
```

CHAP. VI.

Of Reduction.

REduction teacheth to bring any greater name into a lesser, as pounds into shillings, or any small name into a greater, as shillings into pounds.

Reduction of any great denomination into a lesser is thus performed, see how many of the lesser name make one of the greater, and by that number you must multiply the number of

the greater denomination: as if 348*l.* be to be reduced into ſhillings, you muſt multiply 348*l.* by 20. as in this example, the product gives the ſhillings ſought.

348 *l.*
20
6960 *ſh.*

Thus the ſame number of ſhillings will be brought into pence and farthings; *I*f you multiply them firſt by 12, (becauſe 12 *d* is a ſhilling) and then by 4 (becauſe 4 farthings make a penny, as in this example.

6960 *s.*
12
13620
6960
83520 *d*
4
334080 *f.*

Note: By this the learner may know how to divide a leſſer number by a greater, as if it were required to divide 8*l.* amongſt 12 perſons; here it is evident, that each perſon will not receive one pound for his ſhare, but ſome ſhillings and pence: firſt, therefore *I* reduce the pounds into ſhillings (as is taught) *viz.* into 160*s.* this *I* divide by 12. and the quotient, gives 13 *s.* to each perſon, and

4 *s.*

4 *s* remaining, which reduced into 48 *d*, and divided by 12, gives 4*d* to each person, so at last it appears, that if 8 *l*. be divided amongst 12 persons, each share will be 13 *s* 4 *d*.

*I*n like manner if 156 *l*. were to be divided amongst 8 men, the quotient gives 19 *l*. to each man, and 4*l*. remaining, which reduced into 80 *s* and divided by 8, gives 10 *s* more to each person, so each particular share was 19 *l*. 10 *s*.

Reduction of a lesser name to a greater, as of shillings into pounds, is thus performed: finde how many of the lesser makes one of the greater, and by that number you must divide the integers of the lesser name; As if it be requir'd to finde how many pounds are in 36806 shillings, because 20 *s* makes one pound: I divide the number of shillings by 20, and *I* finde 1840 *l*. and 6 *s* remaining, as in this example.

36806	6	(1840 *l*.
xxxx	0	

Note, 1. To reduce ſhillings into *l*s. cut off your laſt figure towards the right hand, and take half of the remaining figures, and if 1 remain, it is a ten, which you muſt put to the figure cut off, for the remaining ſhillings, as in the example following.

8689 (6*s*.
4344*l*.·16*s*.

Note, 2. To reduce Pounds into marks, Multiply the number of pounds by 3 (that brings them into half marks) and divide the product by 2, the quotient gives the marks containd in the number propoſed.

Example, in 368 *l*. how many marks?

368
3
1104

1104 (552 *marks*

Note, 3. To reduce marks into pounds, Multiply the number of marks by 2, and divide the product by

by 3 (for 3 half marks make a pound) the quotient gives the number of pounds, contained in the propoſed number of marks.

Example, in 552 marks how many pounds?

552
2
1104
220
1104 (368 *l.*
33

Queſtions to exerciſe Reduction.

In 36006 *l.* how many ſhillings, pence and farthings.

Anſw. 720120 *s.* 8641440 *d.* 34565760 *f.*

In 360 miles how many barly corns.

Anſw. 1800000 feet 21600000 inches 64800000 barly corns.

In 59000 ſhillings how many *l.*

Anſw. 2950 *l.*

In 960067 farthings how many pence, ſhillings and pounds.

Anſw. 1000 *l.* 20001 *s.* 240016 *d.*

In 36006 marks how many pounds.

Anſw. 54009 *l.*

CHAP. VII.

Notation of Vulgar Fractions.

A Fraction is a part or parts of an integer, or whole, as if you would expreſs 15 *s* or 3 quarters of a yard in figures, you expreſſe it thus $\frac{3}{4}$ three fourths of a pound or yard.

Hence all Fractions are expreſt by 2 figures, whereof the lower denominates the parts into which the integer is divided, and is call'd the nominator or denominator, and the uppermoſt, expreſſeth the number of theſe parts that the Fraction contains, and is called the Numerator.

Note, That 1 or unity is not always the integer or whole, but any num- of pounds, or, *&c.* may be put for the whole, as if the ſtock of 6 Merchants be a 1000 *l.* then we may expreſs the fourth part of the ſtock thus $\frac{1}{4}$ of 1000 *l.*

If the Numerator of any Fraction be leſs than the Nominator then that Fraction is leſs than an integer, and is called

called a proper Fraction, ſuch a one is $\frac{1}{8}$.

If the Numerator of a Fraction be greater than the denominator, ſuch a Fraction is greater than an integer, and is call'd an improper Fraction as this $\frac{2}{4}$.

If the Numerator of a Fraction be equal to the Nominator, then that Fraction is equal to one whole; for $\frac{4}{4}$ is one whole.

The reaſon of all theſe is evident, for the integer contains (as we ſaid) juſt ſo many parts as the Nominator does expreſs.

If any integer be divided into parts, and ſome of theſe be ſubdivided into other parts, then theſe laſt parts are expreſt with two Fractions with the particle (*of*) betwixt them, ſo will 3 farthings be expreſt thus $\frac{1}{4}$ of $\frac{1}{12}$ of $\frac{1}{20}$ of a pound: And ſuch a Fraction is called a Fraction of a Fraction.

When a whole number has a fraction joined to it, then is it called a mixt number, thus $3\frac{1}{4}$ is a mixt number.

CHAA. VIII.

Reduction of Fractions.

1. TO reduce a Fraction of a fraction into one ſingle fraction, Multiply all the numerators continually, ſo is the product a new Numerator, alſo multiply all the denominators continually, ſo is the product a new denominator.

Example $\frac{2}{3}$ of $\frac{3}{4}$ of $\frac{5}{6}$ will be reduced to $\frac{30}{72}$.

2. To Reduce a greater Fraction into the leaſt terms; or to abbreviate a Fraction.

Firſt by a general rule.

Divide the Nominator by the Numerator, and the Numerator by the remainder (if there be any) and thus continue dividing the diviſor by the remainder, till you finde a diviſor that divides without leaving a remainder (but if no ſuch can be found, which always happens when the remainder is 1.) then divide both the numerator and denominator of the

Fraction

Fraction by the divisor, and place the quotients instead of them, then will the Fraction be in its least terms: but if the numerator do divide the Nominator at first without a remainder, then for the Numerator put 1 above the quotient, and the Fraction is reduced.

Example, $\frac{84}{756}$ here the numerator divides the nominator without a remainder, wherefore the Fraction is reduced to $\frac{1}{9}$.

```
   0
756 ( 9/1
 84
```

Example, where the Numerator does not divide without a remainder.

```
 224          128
 ----         1024(4
1024          224

   32          96
  128 (1      224 (1
   96         128

 224 (7       96 (3
  32          32
```

divisor sought.

fraction

6
~~9~~~~0~~~~2~~~~4~~($\frac{7}{32}$ fraction reduc'd to its
~~3~~~~2~~~~2~~ least terms.
~~3~~

2. By particular rules.

When the numerator and denominator are both even numbers they may be divided by 2, as in the example.

$$\frac{28}{32} \mid \frac{14}{16}$$
$$\frac{7}{8}$$

When both end in 5 or one of them in 5 and the other in a cipher, $\frac{25}{50}$ -- $\frac{5}{10}$ - $\frac{1}{2}$ they may be divided by 5.

Lastly, when you can espy any of the 9 figures, or any other number that can divide the Numerator and denominator without a remainder, divide them both by that figure or number, and take their quotients in their stead.

Examples $\frac{24}{48}$ by 12 | $\frac{2}{4}$ by 2 $\frac{1}{2}$
$\frac{164}{986}$ by 2 | $\frac{82}{493}$ cannot be abbreviated.

3. To finde the value of a single Fraction in the known parts of the integer.

Multiply the Numerator of the Fraction

Fraction by the number of known parts of the next inferiour denomination which are equal to the integer, and divide that product by the denominator, so is the quotient the value of the Fraction in that inferiour denomination; and if there happen to be any Fraction in the quotient, you may finde the value thereof, in the next inferiour denomination by the same rule, and so proceed to the least known parts, thus will the value of $\frac{6}{16}$ of a *pound* be found to be 7*s* 6*d*.

$$\frac{6}{16} \quad \begin{array}{r} 6 \\ 20 \\ \hline 120 \end{array}$$

$$\begin{array}{r} 8 \\ 12 \\ \hline 96 \end{array} \quad \begin{array}{l} \cancel{8} \\ \cancel{120}(7s.\frac{3}{16} \\ \cancel{16} \\ \cancel{96}(6d \\ \cancel{16} \end{array}$$

4. To Reduce a mixt number into an improper Fraction.

Multiply the whole number into the denominator of the Fraction joyned to it, & to the product add the numerator of the Fraction, the sum place, for a new Numerator above the denominator of the Fraction, and you have the improper Fraction required. *Example.*

$\frac{2}{34}$ *l.* to this $\frac{14}{4}$

5. To

5. To Reduce a whole number into an improper Fraction.

Under the whole number place 1 as a denominator, thus, 14 *l.* is $\frac{14}{1}$.

6. To Reduce a whole number into an improper Fraction having any denominator assigned.

Multiply the whole number by the denominator assign'd, and place that product above the said denominator thus 8 *l.* into a Fraction whose denominator is 4.

8 *l.* 4.
$\frac{4}{32}$ $\frac{12}{4}$

7. To Reduce an improper Fraction into its equivalent whole or mixt number.

$\frac{18}{4}$
2
18(4 *l.* $\frac{2}{4}$

Divide the numerator by the denominator, so is the quotient the whole or mixt number sought.

8. To alter a Fraction, or to reduce a Fraction into another equivolent to it, having any denominator assign'd.

Multiply the Numerator of the Fraction by the denominator assign'd, and divide the product by the denominator of the Fraction, the quotient gives

gives a numerator to the denominator assign'd.

Example, what is $\frac{5}{8}$ of 16 *s* or to reduce $\frac{5}{8}$ to a Fraction whose denominator is 16.

$$\begin{array}{r|l} 80 & 16 \\ 8 & 10\,s \end{array} \qquad \frac{5}{80}$$

9. To reduce 2, 3 or more Fractions that have unequal denominators, to Fractions of the same value that have equal denominators.

Multiply all the denominators one into another continually, and set down the product several times for a new denominator, then multiply the first Numerator into all the denominators save its own, and set that product for a new Numerator to the first fraction, and so multiply the second, the third, *&c.* into all the denominators save their own, and set down their products for new Numerators above the common denominator, and they give the Fractions sought.

Example.

$$\frac{2}{3}\ \frac{3}{4}\ \frac{5}{6}\ \frac{3}{5}\ 1 \qquad \frac{242}{360}\ \frac{272}{360}\ \frac{300}{360}\ \frac{216}{360}$$

Note,

Note, That if you take away the common denominators, then are the new Numerators whole numbers, having the proportion that the Fractions given have.

CHAP IX.

Addition of Vulgar Fractions.

ADdition of ſingular Fractions: If they have one common denominator, then add their Numerators, and write that ſum above the common denominator: ſo if you add $\frac{2}{8}$ and $\frac{4}{8}$ the ſum is $\frac{6}{8}$.

If the ſingle Fraction have not the ſame common denominator, then you muſt reduce them by the 9th reduction, ſo if $\frac{1}{4}$ and $\frac{4}{5}$ were to be added, their ſum would be found $\frac{21}{20}$.

2. Addition of fractions of fractions.

Firſt, reduce the fractions of fractions to ſingle fractions by the firſt reduction, and then add them as is taught, thus will the ſum of $\frac{1}{3}$ of $\frac{1}{8}$, and $\frac{2}{5}$ of $\frac{1}{6}$ be found to be $\frac{29}{72}$.

Note,

Note, that the fractions given to be added in all the former cases, are supposed to be of the same denomination, that is, parts of the same integer or whole; so that if one be a fraction of a pound *sterl.* then the rest are supposed to be parts of a pound also, and the like is to be understood of other denominations.

3. Addition of fractions of integers of different denominations.

First, reduce them to fractions of Integers of the same denomination, by expressing them by compound fractions, and then bring them into single fractions by the first reduction, and lastly add them, as is taught.

Example, add $\frac{3}{9}$ of 2 pound *sterl.* $\frac{1}{4}$ of a penny, I reduce $\frac{1}{4}$ of a penny into this, *viz.* $\frac{1}{4}$ of $\frac{1}{12}$ of $\frac{1}{20}$, which by the first reduction is $\frac{1}{960}$, which added to $\frac{3}{9}$ as is taught, gives the sum $\frac{6741}{8640}$, and thus add fractions of any other differing denominations.

4. To add whole numbers and fractions: reduce the whole number to a fraction, having the same denominator with the fraction given (by the 6th

6th Red.) then add them, as is taught.

5 Addition of mixt numbers.

Firſt, finde the ſum of the fraction joyned to them (by the former rules) and if there be any integers, in that ſum, add them to the Integers, and place their ſum,& the fraction remaining (if there remain any)together;& you have the total ſum thus; will the ſum of the integers in the example be found.

64*l.*—$\frac{2}{3}$
94—$\frac{1}{5}$
86—$\frac{8}{9}$
245—$\frac{122}{135}$

CHAP. X.

Subſtraction of Vulgar fractions.

1 IF the fractions given be both ſingle fractions, and have equal denominators; then ſubſtract the leſſer Numerator from the greater; and place the remainder over the common denominator; the fraction is the difference of the fractions, ſo $\frac{2}{3}$ from $\frac{1}{3}$, there remains $\frac{1}{3}$.

2. If the numbers given, be ſingle fractions

fractions and have unequal denominators, then reduce them to fractions having the ſame denominators (by the 9th Red.) and ſubſtract, as before thus: $\frac{2}{4}$ from $\frac{5}{6}$, they are firſt reduced to $\frac{12}{24}$ $\frac{20}{24}$ and then the remainder is $\frac{8}{24}$ or $\frac{1}{3}$.

3. Subſtraction of fractions of fractions.

Firſt, reduce them to ſingle fractions of the ſame denomination (by the firſt and 9th Red.) and then ſubſtract, as is taught, thus, $\frac{1}{3}$ of $\frac{4}{9}$ from $\frac{1}{4}$ of $\frac{3}{5}$ the remainder will be found to be $\frac{13}{216}$.

4. To ſubſtract a fraction from a whole number.

Reduce the whole number to a fraction, having the ſame denominator with the fraction given (by the 6th Red.) and then ſubſtract, as is taught in the firſt rule of this Chapt. thus $\frac{5}{8}$ from 4 *l.* the integers are reduc'd to $\frac{32}{8}$, and then the remainder is found $\frac{27}{8}$ or 3 *l.* $\frac{3}{8}$.

Or thus, ſubſtract the numerator of the fraction from the denominator, and ſet down the remainder above the ſame denominator, to which ſet down

down the integers lesse by 1, that mixt number is the remainder, as before: thus, if you substract $\frac{3}{4}$ from 6 *l.* the remainder is found to be 5 *l.* $\frac{1}{4}$.

5. To substract a mixt number from a mixt number.

If the fraction of the greater number from which we are to substract, be greater then the fraction of the lesser number, then, first substract the lesser fraction from the greater (by the first & second rules of this Chap.) and note down the remainder; then substract the lesser whole number from the greater, placing that remainder to the former remainder, so is that mixt number the whole remainder or difference of the fractions given; example, 3 *l.* $\frac{3}{8}$ from 2 $\frac{1}{5}$ first $\frac{1}{5}$ from $\frac{3}{8}$ by the second rule rests $\frac{7}{40}$ then 2 *l.* from 3 *l.* rests 1, so is the remainder 1 *l.* $\frac{7}{40}$.

6. If the fraction of the greater number be lesse then the fraction of the lesser number, then reduce the fractions (by the 9th Red.) and substract the numerator of the greater fraction from the common denominator, to the remainder add the numerator

rator of the leſſer fraction, this ſum place above the common denominator, then to the leſſer whole number add 1, and ſubſtract the ſum from the greater number; laſtly, place the remainder to the laſt fraction, and you have the mixt number ſhewing the remainder or difference.

Example, 17 *l.* $\frac{1}{4}$ from 22 *l.* $\frac{4}{9}$ firſt $\frac{3}{4}$ and $\frac{4}{9}$ are reduced to $\frac{27}{36}$ $\frac{16}{36}$ then 27 from 36 reſts 9 and 16 make $\frac{25}{36}$ for the fractional remainder: laſtly, 17 and 1 is 18 from 22 reſts 4, the whole remainder is 4 *l.* $\frac{25}{36}$.

To know which of any two or more fractions is greateſt.

Reduce them (by the 9th Red.) to the ſame denomination and then theſe that have the greater numerators are the greater fractions.

CHAP. XI.

Multiplication of Vulgar Fractions.

1. IF the fractions to be multiplied be ſingle fractions, then multiply the

the numerators one into another, and set that product for a new numerator, also multiply the denominators one into another, and set their product for a new denominator, the new fraction gives the product, thus $\frac{2}{3}$ by $\frac{3}{4}$ make $\frac{6}{12}$ or $\frac{1}{2}$: also $\frac{2}{4}$ $\frac{1}{8}$ & $\frac{3}{4}$ multiplied continually make $\frac{6}{128}$ or $\frac{3}{64}$.

2. If the numbers given be mixt numbers, or whole numbers and Fractions, or Fractions of Fractions; first reduce them into single Fractions (by the 4th 5th or first Reductions) and then multiply them, as is taught.

Examples, $2\frac{1}{3}$ by $1\frac{2}{4}$, they are first reduced to $\frac{7}{3}$ and $\frac{6}{4}$ then the product is found to be $\frac{42}{12}$ or $3\frac{6}{12}$ or $3\frac{1}{2}$.

Example, 2. 4*l*. by $\frac{2}{3}$ the product is $\frac{8}{3}$

Example, 3. $\frac{2}{3}$ of $\frac{5}{8}$ by $\frac{1}{4}$ of $\frac{3}{6}$ the product is $\frac{30}{576}$ or $\frac{5}{96}$.

3. To take any part or parts of any number.

Multiply the number by the Fraction expressing the part or parts, and the product gives the parts desired: thus the $\frac{1}{6}$ of 54 is found to be $\frac{54}{6}$ or 9: likewise the $\frac{2}{8}$ of 144 is $\frac{432}{9}$ *s* or 5*l*. the $\frac{4}{9}$ of 108 is $\frac{432}{9}$ or 48*s*.

CHAP

CHAP. XII.

Division of Fractions.

1. IF the numbers given, be ſingle fractions, then multiply the numeration of the dividend into the denominator of the diviſor, the product is a new Numerator; alſo multiply the denominator of the dividend into the Numerator of the diviſor, the product is a new denominator, the Fraction is the quotient.

Example, $\frac{2}{3}$ by $\frac{1}{5}$ quotient $\frac{10}{3}$ alſo $\frac{1}{4}$ by $\frac{2}{6}$ quotient $\frac{18}{8}$.

2. If the numbers given be not ſingle Fractions, then they muſt be reduc'd to ſingle Fractions by the preceeding reduction.

Example, 2 *l.* $\frac{2}{3}$ by 1 *l.* $\frac{1}{5}$ they muſt be firſt reduc'd to $\frac{8}{3}$ and $\frac{6}{5}$, and then the quotient is $\frac{42}{18}$ or 2 $\frac{6}{18}$ or 2 $\frac{2}{9}$. alſo 3 *l.* by $\frac{3}{3}$ the quotient is $\frac{2}{2}$ or 4 $\frac{1}{2}$. Likewiſe $\frac{2}{3}$ of $\frac{1}{4}$ by $\frac{2}{8}$ of $\frac{2}{10}$, they are firſt reduced to $\frac{6}{12}$ or $\frac{1}{2}$ and $\frac{18}{80}$ or $\frac{9}{40}$, and the quotient found to be $\frac{42}{18}$.

It may ſeem ſtrange to young

learners, that when proper Fractions are multiplyed (that is Fractions that are less than one whole or unity) the product is less than either of the Fractions, as $\frac{2}{3}$ by $\frac{3}{4}$ the product is $\frac{6}{12}$ or $\frac{1}{2}$, which is less than either of the Fractions given, but the thing is demonstrable out of the definition of Multiplication; for seeing that $\frac{3}{4}$ multiplying $\frac{2}{3}$ does produce $\frac{6}{12}$; 1 or unit is to the multiplier $\frac{2}{3}$, as the multiplicand $\frac{3}{4}$, is to the product; but 1 or unit is greater than the multiplier $\frac{2}{3}$, therefore the multiplicand $\frac{3}{4}$ must be also greater than the product $\frac{6}{12}$.

Again, if $\frac{3}{4}$ by multiplying $\frac{2}{3}$, do produce $\frac{6}{12}$ than as 1 or unit is to $\frac{3}{4}$, so is $\frac{2}{3}$ to the product $\frac{6}{9}$, but 1 or unit is greater than $\frac{3}{4}$ therefore is $\frac{2}{3}$ also greater than the product $\frac{6}{12}$.

If one of the numbers given to be multiplied be greater than 1 or unit, then the product will be less than it, but greater than the other which is less than an unit.

It may seem no less strange, that in division of proper Fractions, and wherever the divisor is less than an unit

unit, the quotient is always greater than the dividend, but the reason is likewise manifest out of the definition and nature of division: Example, if $\frac{3}{4}$ be divided by $\frac{2}{3}$, the quotient is $\frac{11}{8}$. By the definition of division an unit is to the quotient, as the divisor is to the dividend, therefore by changing; as an unit is to the divisor, so is the quotient to the dividend, but we suppose the divisor to be always less than an unit, therefore will the dividend be likewise less the the quotient.

CHAP XIII.

The Rule of Three.

THis Rule is so called, because in it there are 3 numbers given to find a 4th: It is also called the Golden Rule, because of its frequent and excellent use.

Of the 3 numbers given, two are always of the same name, and the question is annexed to one of them;

the other is of the ſame denomination with the 4th required; as in this queſtion.

If 12 yards coſt 3 *l.*——12 *s.* what will 16 yards coſt?

Here 12 yards and 16 yards are of one name, and the queſtion is annexed to 16; and the other, *viz.* 3 *l.*——12 *s.* is of the ſame name with the 4th.

Of the 3 given numbers, two muſt always be multiplyed together, and their product muſt be divided by the other number, for the quotient gives the 4th ſought.

Hence all the difficulty lies in diſcovering the diviſor, which is always one of theſe numbers that are of the ſame name; and which may be thus diſcovered.

If the number that asketh the queſtion be greater than that of the ſame denomination, and alſo requires more, or if it be leſſe and requires leſſe, then that number which is of the ſame denomination with the number which asketh the queſtion, is the diviſor.

But if the number which asketh the queſtion be greater than that of the ſame

ſame name, and yet requires leſs, or if it be leſs, and requires more, then the number which asketh the queſtion is the diviſor.

Having diſcovered your diviſor, Multiply the other two numbers together, and divide their product by the diviſor, the quotient gives the 4th ſought.

If any of the given numbers be in ſeveral denominations, they muſt be reduc'd into the leaſt denominations expreſt in the queſtion. As in the queſtion firſt propounded, I reduce the 3 *l.* to ſhillings, and work as is taught, thus.

12 *yds.*——3*l.*——12*s.*——16*yds.*

Diviſor 20

12——72 *s.*——16

16

432

72

1152

(9) 60*s.*

4*l.*——16*s.*

ſo that 16 yards will coſt 4 *l.*——16 *s.*

You may by this brief rule following eaſily diſcover your diviſor, *viz.*

Eſteem the numbers of one name, *viz.* the firſt and the third as extremes, in reſpect of the ſecond, then ſee by the tenour of your queſtion, whether the third number require more or leſs, that is, a greater or a leſs number than the ſecond; then if it require more, the leſſer extreme is your diviſor, if leſs, the greater extream is your diviſor: ſo in the laſt queſtion, 16 yards requires a greater ſum or price, than 3 *l.* 12 *s.* therefore 12 being the leſſer extrem, is the diviſor, as before.

More Examples of this Rule.

There are 1500 ſoldiers in garriſon in a City beſieged, and have proviſions to ſerve them 7 months, the queſtion is, how many muſt be diſbanded, that the proviſion may ſerve 12 moneths; rank the numbers thus,

moneths *ſoldiers* *moneths.*

7——1500——12.

here by the tenour of the queſtion there

there is a fewer number of men required, therefore the greater extreme *viz.* 12 is the divisor, which being discovered, work as below,

mon.	*Sold.*	*mon.*
7	1500	12
1500	7	
875	10500	96
625		10500(875
		1222
		11

here we see the provision will serve 875 men 12 moneths, therefore the rest must be disbanded: to the number of 625. as is found by substracting 875 from 1500.

If 17 yards of Cloth cost 18*l.* 19*s.* 10*d*, what will 45 yards cost?

17*yds.*	18*l.*	19*s.*	10*d.*	45*yds.*
	20			
	379			4558
	12			45
	768			22790
	379			18232
	4558*d*			205110
				3195

3195 d
205110 (12065 $\frac{5}{17}$
177777
1111
(5 d
12065 (100 (5 s.
22222
111 50 l. 5 s. 5 d. $\frac{5}{17}$

If 50 *l.*—5 *s* buy 28 yards, how many will 17 *l.* 11 *s* 6 *d* buy?

50 *l*—5 *s*—28 *yds*—17 *l*—11 *s*—6 *d*

20	20
1005	251
12	12
2010	702
1005	3516
12060 *d.*	4218 *d.*
	28
	33744
	8436
	118104

956
118104 (2 *yds* 9564
12060 13060

207 (6 9564
3825 (3 *qu.* 2076 | 4
12060 12060 | 38256 *qu.*

If

If one pay 36 *s* 6 *d* for 9 yards how many yards of the same stuff can be bought for 34 *l.*

36 *s.* — 6 *d* — 9 *yds* —		34 *l.*
12		20
72		680
366		12
d		1360
438		680
33(29		8160
2966(4		9
73440	(167 *yds* and	73440
43888		
433	$\frac{294}{438}$ that is almost $\frac{1}{2}$ a *yd.*	
4		

If I lend my friend 200 *l.* for 365 days how long ought he to lend me 120 *l.* to requite my courtesie?

l.	*d.*	*l.*
200 —	365 —	120.
	200	
	73000	

1 4
7300
1222 (608 *days* & $\frac{4}{12}$ or $\frac{1}{3}$.
11

which divide by 365 (the days in one year and 243 days.

The proof of the Rule of Three.

Multiply the 4th number by the divisor, and if that product be equal to the product of the other two numbers given, then is your work true; if it be not equal the operation is false. Example. There is a field which 8 mowers can mow in 9 days, but necessity requires that it must be mowed in 4 days, I demand how many mowers can mow it down in that time?

If 9 *d*—8 *m*.—4 *d*.

9   8

72   72 (18 *mowers.*

44

proof.

If 18 mowers can mow down a field in 4 days, how many mowers can mow down the same field in 9 days?

If 4 *d*—18 *m*—9 *d*

4

72   72 (9

8

here

here 8 and 9 make the same product with 18 and 4, therefore the work is true.

Arithmeticians commonly distinguish the Rule of Three into two rules, one they call the direct, and the other the inverse rule of 3, which distinction is nothing else but this; If the number which is in the first place, which is of the same name with that which asketh the question, be the divisor, then it is the direct rule of 3. But if the 3d number which asketh the question be the divisor, it is the inverse rule of 3.

CHAP. XIV.

The Rule of 3. in Fractions.

WHen the numbers given are Fractions, then is it called, the Rule of 3. in Fractions.

Rank your numbers given, and finde out your divisor as in whole numbers, then multiply the two numbers, and divide by the divisor, according

cording to the Rules of the 11th and 12 Chapter, the quotient gives the 4th required.

Example.

If $\frac{3}{4}$ of a *yd* cost $\frac{5}{8}$ of a pound, what cost $\frac{5}{4}$ of a yard?

If $\frac{3}{4}$ *yd*——$\frac{5}{8}$ *l.*——$\frac{5}{4}$ *yd*

divis. *num.*

Answ. 1 *l.*—10 *d* $\frac{3}{4}$X$\frac{25}{32}$ *denom.* $\frac{100}{96}$

4

$\cancel{100}$ (1 *l.* $\frac{4}{96}$] $\frac{1}{24}$

$\cancel{99}$

when you have rank'd your number so, as these that are of the same name stand in the first and third places, and the other in the middle and have found your divisor then you may thus brieflysinde the 4th sought, *viz.* Multiply the denominator of your divisor into all the Numerators save his own, that product set for a new Nemerator; likewise Multiply the Numerator of the divisor into all the denominators saves his own, and place that product for a new denominator, the new fraction is the 4th number sought.

Examples

Examples.

If 1*l*. 10*d*. buy $\frac{4}{5}$ of a yard what will $\frac{3}{4}$ of a yard cost?

If $\frac{5}{4}$ *yd*—1 *l*.—10 *d*—$\frac{3}{4}$

first the fraction $\frac{1}{24}$ is found

10 *d* is $\frac{12}{12}$ of $\frac{1}{20}$.

or $\frac{1}{24}$ | $\frac{2}{0}$ $\frac{1}{24}$

$\frac{5}{4}$ *yd*—1 *l*. $\frac{1}{24}$—$\frac{3}{4}$

then is the mixt number reduc'd.

$\frac{25}{24}$ 25

5 4

120 100

4 3

denom. 480 *Nnm.* 300

20 to value $\frac{5}{8}$ $\frac{32}{48}$ | $\frac{2}{0}$ | $\frac{5}{8}$

5

100

2(4

~~100~~(12 *s*, $\frac{41}{812}$

38

Answ. 12 *s*.—6*d*.

If the $\frac{3}{16}$ of a ship be worth 150 *l*. 3, what is $\frac{3}{4}$ of that ship worth?

ship *l.* *ship*

If $\frac{3}{16}$—150 $\frac{2}{3}$—$\frac{3}{4}$

$\frac{2}{3}$ 452

$\frac{3}{9}$ $\frac{16}{2712}$

denom. $\frac{4}{36}$ $\frac{452}{7232}$

$\frac{21696}{36}$ *quot. num.* $21696\frac{3}{}$

0(24

$$\begin{array}{l} \cancel{0}(24 \\ \cancel{2}\cancel{1}\cancel{6}\cancel{9}\cancel{6} \\ \cancel{3}\cancel{6}\cancel{6}\cancel{6}\,(602\,l.\ \tfrac{24}{36}\big|\tfrac{2}{3} \\ \cancel{3}\cancel{3} \end{array}$$

Answ. 602 *l.*——13*s*——4*d*

If a man lends his friend 30*l.* $\frac{5}{8}$ for $\frac{3}{12}$ of a year, how long ought his friend to lend him 100*l.* $\frac{2}{3}$ to require his Courtesie?

$$\begin{array}{lccc} & l. & year & l. \\ \text{If} & 30\ \frac{5}{8} & \frac{3}{12} & 100\ \frac{2}{3} \\ & \frac{8}{245} & \frac{1}{4} & \frac{3}{302} \\ & 8 & & 3\ \textit{divisor.} \end{array}$$

$$\begin{array}{lll} & & 245 \\ \frac{735}{9664}\ \textit{quot.} & \textit{num.} & 73\frac{3}{5} \end{array}$$

Answer, 27 days as is found by valuing the fraction $\frac{735}{9664}$

$$\begin{array}{ll} & 302 \\ & 120\frac{4}{8} \\ \textit{denom.} & 9664\frac{8}{} \end{array}$$

If $3\frac{1}{2}$ yards of $1\frac{3}{4}$ broad Cloath will make a Cloak, how much stuff of $\frac{5}{8}$ of a yard in breadth, will make a Cloak of the same bigness?

brea.

brea. *leng.* *brea.*

If $1\frac{3}{4}$ *yd* —— $3\frac{1}{2}$ *yd* —— $\frac{5}{8}$ *yd*

$\frac{7}{4}$ —— $\frac{7}{2}$ —— $\frac{5}{8}$

7 *divisor.*

$\cancel{3}$

$\cancel{39}\cancel{2}$ (9 *yd* $\frac{32}{40}$ | $\frac{1}{5}$ —— $\frac{5}{10}$ —— $\frac{8}{56}$

$\cancel{4}\cancel{0}$

denom. 40 *num.* 392

Answ. 9 *yds* —— $\frac{4}{5}$

The proof of this Rule is the same with that in whole numbers.

Example.

If 9 *yds.* $\frac{4}{5}$ of $\frac{5}{8}$ *yd.* broad stuff make a Cloak, how much of $1\frac{3}{4}$ *yds.* broad Cloath will make a Cloak of the same bigness.

yd $\frac{5}{8}$ *brea.* —— *leng.* $9\frac{4}{5}$ *yd* —— *brea.* $1\frac{3}{4}$ *yd*

$\frac{5}{8}$ —— $\frac{49}{5}$ —— $\frac{7}{4}$ *div.*

14 $3\frac{7}{5}$ 49

$\cancel{38}$|0 (3 *yd* $\frac{14}{28}$ | $\frac{1}{2}$ $\frac{8}{280}$ 4

$\cancel{28}$|0 280 *denom.* 196

5

Answ. $3\frac{1}{2}$ *yds* *Num.* 980

here the same nnmber is found, and the breaths multiplied by their particular lengths give equal products.

Questions to exercise the Rule of three

three in whole numbers and fractions

If 35 yards coſt 48*l*. 5*s*. what will 15 yards coſt? Anſw. 20*l*. 13 *s*. 6 *d*. $\frac{6}{7}$.

If $3\frac{1}{2}$ yards of velvet coſt 2 *l*. $\frac{3}{5}$ what will $\frac{3}{4}$ yards coſt? Anſw. 11 *s*. 5*d* $\frac{1}{7}$.

If 12 men can mow a field in $6\frac{1}{2}$ days, how long time will 5 men take to mow the ſame field? Anſw. 15 $\frac{1}{5}$ days.

There were 50 Cloaks bought for 90 *l*. and ſold for 105 *l*. if they had bought for 70 *l*. how ſh uld they have been ſold to have gained after the ſame rate? Anſw. 81 *l*. 13 *s*. 4*d*.

If a wedge of Gold weighing 45 *l*. $\frac{2}{3}$ be worth 196 *l*. $\frac{5}{8}$ what is 5 penny weight of that Gold worth? Anſwer, 14 *s*. 5 *d*. 1 *f*. fere.

If $20\frac{2}{3}$ lb. of ſaffron coſt 3 *l*. $\frac{2}{5}$ what will $\frac{3}{16}$ of a lb. coſt? Anſw. $\frac{5}{7}$ *s* 4*d* 3*f*. $\frac{1}{31}$.

One ſelleth Cloath for 350 *l*. and gains at the rate of 10 *l*. in the 100 *l*. what was the principal, and what the clear gain? Anſwer, the principal 318 *l*. $\frac{2}{11}$ gain 31 *l*. $\frac{2}{11}$.

A City beſieg'd has victuals to maintain its gariſon, Soldiers in number 5200 for $9\frac{1}{3}$ moneths, but they are

to

to expect no relief till 14 ¼ moneths; I demand how many Soldiers must be sent out that the provision may suffice till the relief come. Answer, 2600 must be sent away and 2600 must remain in garrison.

If one for every 4 weeks receive 33*s*. 6*d*. how much must they receive for a year and ½ that is in Arrear?

Answer. 32*l*—14*s*—3*d*

Rules of Practice by Aliquote parts.

When in the Rule the divisor is 1, then may the 4th sought be found out by more speedy and practical ways than those of the Rule of Three. And they are called Rules of practice by Aliquote parts.

An Aliquote part of a number, is such a part which being taken certain times, does precisely constitute the number, as 4 is an aliquot part of 20, for taken 5 times it doth exactly make 20, and 3 is an aliquote part of 12, for taken 4 times it exactly makes 12.

It

It is neceſſary that the learner before he proceed, have by heart the table of twelves, together with theſe tables of the aliquote parts of a pound and of a ſhilling, which are ſet down.

	s.	*d.*			*d.*	*f.*
	10	0 is $\frac{1}{2}$			6	0 $\frac{1}{2}$
	6	8 is $\frac{1}{3}$				
The even	5	0 is $\frac{1}{4}$	*The even*		4	0 $\frac{1}{3}$
parts of a	4	3 is $\frac{1}{5}$	*parts of a*		3	0 $\frac{1}{4}$
pound.	3	4 is $\frac{1}{6}$	*ſhilling.*		2	0 $\frac{1}{6}$
	2	6 is $\frac{1}{8}$			1	2 $\frac{1}{8}$
	2	0 is $\frac{1}{10}$			1	0 $\frac{1}{12}$
	1	0 is $\frac{1}{20}$				

1. When the price of 1 or an integer is an even part of a pound, divide the Integers whoſe price are required by the denominator of that even part, the quotient will be the price of the Integers in pounds; and here obſerve once for all, that

times		*is*
2	12	24
3	12	36
4	12	48
5	12	60
6	12	72
7	12	84
8	12	96
9	12	108
10	12	120
11	12	132
12	12	144

that when any thing remains after diviſion, it is of the ſame denomination as the dividend was.

½ 666 *ys* at 10*s* *p.yd*	⅓ 206 *ys* at 6*s*8*d* *yd*
333 *l.*	68*l.*—13*s*—4*d*
¼ 420 *ys* at 5*s* *p.yd*	⅛ 504 *ys* at 2*s*6*d* *yd*
105 *l.*	63 *l.*

2. When the given price is an even number of ſhillings, and are not an even part of a pound, then Multiply the number of Integers whoſe price are requir'd, by half the given number of ſhillings, with this caution, that the double of the figure which ariſeth, in the firſt place of the product, be writren a part as ſhillings and the reſt of the product as pounds.

86 *yds* at 8 *s. p. yd.*	48 *yds* at 16 *s p. yd.*
4	8
34*l.*—8*s*	38*l.*—8*s*

3. When the given price of an integer is an odd number of ſhillings, and not an even part of a pound, then work for the greateſt even numbers of ſhilings contained in that odd number, according to the firſt, or ſecond rules preceding, then for the odd ſhillings remaining,

remaining, take $\frac{1}{20}$ of the number of integers whose price are required, these two results added together, give the whole price sought.

458 *yds* at 9*s* *p.yd*	86 *yds* at 11*s*. *p.yd*
183 *l.*——4*s.*	43 *l.*
22——18	4——6
206——02	47——6*s*

4. When the given price of an integer is pounds and shillings, first multiply the number of integers, whose price are required by the number of pounds in the given price, and subscribe the product as pounds, then proceed with the shillings, as is taught, the sum of the two results is the price required.

28 *yd* at 3*l.*5*s* *p.yd*	30 *yd* at 5*l.*9*s* *p.yd*
	5
3	150 *l.*
84	12——·0*s*
7	1——10
91 *l.*	163——10*s.*

5. When the price of an integer is an even part of a shilling, multiply the given number of integers whose price are

are required by the denominator of the even part, the product gives their price in shillings, which are easily reduced into pounds by the brief rule in the 6th Chapter.

84 *yds* at 8*d* *p.yd* — 42 *s.* — 2 *l.* — 2 *s*

96 *yds* at 3*d* *p.yd* — 24 *s.* — 1 *l.* — 4 *s.*

6. When the given price of an integer is not an even part of a shilling, then it is made up of two even parts of a shilling, as 7*d* is made up of 4, which is $\frac{1}{3}$ and which is $\frac{1}{4}$ of a shilling wherefore work for the 2 even parts of a shilling severally, the sum of their quotients give the price in shillings;

84 *yds* at 9*d* *p.yd*

$\frac{1}{2}$ 42
$\frac{1}{4}$ 21

63

3 *l.* 3 *s.*

48 *yds* at 7$d\frac{1}{2}$ *p.yd*

$\frac{1}{2}$ 24
$\frac{7}{8}$ 6

30 *s.*

1 *l.* 10

7. When the price of the integer consists of shillings and pence; first multiply the integers whose value is required, by the shillings and subscribe

ſcribe the product as ſhillings, then divide the ſaid number of integers, by the denominators correſpondent to the even parts contained in the given number of pence, and ſubſcribe the quotient, underneath, the aforeſaid product, the ſum of all gives the price required.

36*yds* at 5*s* 8*d* *p.yd*

	5
	180 *s.*
$\frac{1}{2}$	18
$\frac{1}{6}$	6
	2014
	10*l.* 4 *s.*

40*yds* at 6*s* 9*d* *p.yd*

	6
	240
$\frac{1}{2}$	20
$\frac{1}{4}$	10
	2710
	13*l.*—10*s.*

86*yds* at 6*s* 8*d* *p.yd*

$\frac{1}{3}$ 21*l.* 13*s.* 4*d.*

45*yds* at 2*s* 6*d* *p.yd*

$\frac{1}{8}$ 5*l.*—7*s.* 6*d.*

8. Whe

8. When the price consists of pounds, shillings and pence reduce the said pounds and shillings all into shillings then proceed as is taught.

48*yds* at 3*l* 5*s* 9*d* p. *yd*		94*ys* at 2*l* 11 5*d* p. *yd*	
65*s*.	48	51*s*.	94
	65		51
	240		94
	288		470
	3120		4794
$\frac{1}{2}$	24	$\frac{3}{4}$	23 6*d*
$\frac{1}{4}$	12	$\frac{1}{6}$	15 8*d*
	315--6		433 · 3--2*d*
	157*l*. 16*s*		241*l*. · 13 5 2*d*

9. When the price of an integer is pence, together with $\frac{1}{2}d$ or $\frac{3}{4}d$; then it will be convenient to work for all the given number of pence, except 1*d* and the said $\frac{1}{2}$ or $\frac{3}{4}$ *d* : then for that penny $\frac{1}{2}$ penny take $\frac{1}{8}$ of the number of integers propounded, and if there be yet a farthing, take $\frac{1}{6}$ of the said quotient which ariseth by taking $\frac{1}{8}$, both these quotients give the value of the integers.

86 *yds*

86 *yds* at 9*d* ¾ *p. yd*

⅓	28—8*d*
⅓	28—8
⅛	10—9
⅙	1—9½
	69—10½
	3*l.*—9*s*—10*d* ½

94 *yds* at 7*d* ½ *p. yd*

¾	23—6*d.*
¼	23—6
⅛	11—9
	58—9
	2*l.*—18*s.*—9*d.*

10. When the price of an integer is given, and the price of many integers together with ½, ⅓ or ¼, *&c.* is required, first finde the value of the integer whose price are required, then for the ½ or ⅓, *&c.* take ½, or ⅓ of the given price of an integer; and add to the former sum. *Example,*

If 1 yard cost 3*s* 9*d*, what will 360 *yds* ¼ cost?

3

6*d* is—½—1080 *s.*

180

3*d* is—¼— 90

1350

then ¼ of 3*s*—9*d* is—2—9—¾

1352—9—¾

67*l.*—12*s.*—9*d*—¾

Example

Example.

If 1 C. cost 3*l.*——16*s.*——5*d* $\frac{1}{2}$ what 84 C. 3 *qu.* *lb.* 25?

76*s.*——5*d* $\frac{1}{2}$	84
	76
	504
	588
	6384*s.*
4*d.* is $\frac{1}{3}$	28
1*d* $\frac{1}{2}$ is $\frac{1}{8}$	10—6*d*
for 2 *qu.* take $\frac{1}{2}$ the	6422*s*—6*d*
given price	38—2—3*f.*
for 1 *qu.* take $\frac{1}{2}$ the last sum	19—1—1x
then for 14*l.* which is $\frac{1}{8}$ of 1 C. take $\frac{1}{8}$ of the given price, or else take $\frac{1}{2}$ the price of $\frac{1}{4}$ C. or 1 *qu.*	9—6—2x
and for 7*l* take $\frac{1}{2}$ the price of 14*l.*	4—9—1x

And lastly for the 4*l.* remaining take $\frac{4}{7}$ of the last sum, by multiplying the number by 4, and dividing the product by 7 the quotient is——— 2—8—3*f*

sum of all	649-6—10—2x
	324-16—10—2x

the parts of a farthing are omitted in this Example, but are supposed to follow the signe x, for which allow-

ance ought to be made in the sum-
ing up of all the numbers; albeit in th
resolving of questions after this pra-
ctical manner, some error will hap-
pen yet the loss for most part will b
less than a farthing, and so inconside-
rable.

Of *Tare* and *Tret.*

TAre and Tret are allowances us
in Merchandize upon many sort
of commodities; the rate or proport
on being agreed upon and known; th
Arithmetical work will be quickly di
patcht, as in the following examples.

1. When the price of a pound ne
is given, together with the number
pounds tare, and the price of hundre
gross is required: Reduce your hu
dreds gross into pounds gross, a
substract the pounds tare, the remain
der is pounds neat, whereof you ma
finde the price by the former rules.

Examp

Example;

45 C. groſs tare 510 *lb.* at 9*d. p. lb.* neat.

45
112
90
45
48
5040 *lb.* groſs.
510 *lb.* tare.
4530 *lb.* neat.
4530 at 9*d p. lb.*
½ 2265
¼ 1132 ——— 6*d.*
33917 ——— 6*d.*
169*l.* — 17*s* — 6*d*

38 C. groſs, tare 70*l.* at 7*d. p. lb.* neat.

30
112
60
30
30
3360 *lb.* groſs.
70 *lb.* tare.
3290 *lb.* neat.
3290 *lb.* at 7*d p. lb*
½ 1645
1/12 274 ——— 2*d.*
19119 ——— 2*d.*
95*l.* — 19*s.* — 2*d.*

2. If the price of a pound neat and the allowance of tare *per* bag, barrel or *p.* C. be given, and the price of C's. groſs be required, then multiply the tare given, by the number of bags barrels or C's given, and the product will be *l's* tare, which ſub-

ſtract from the *ls.* groſs and the remain-
der is *ls.* neat, then finde the value a
in the laſt example.

Example.

44 C. groſs, tare 12 *lb. p.* C. at 8*d. p. lb.* neat.

44	44 C.
112	12
88	88
44	44 *lb.*
44 tare	528
4928 *lb.* groſs.	
528 *lb.* tare.	
4400 *lbs.* neat	
4400 at 8*d.* &c.	
½ 2200	
⅙ 733 ——	4*d.*
2931 3 ——	4*d.*
146*l.* — 13*s* —	4*d*

44 C. tare 17*l p*
C. at 7*d. p.* pou
neat.

44	44 C
112	17
88	308
44	44
44 tare	748 *lb*
4928 *lbs.* groſs.	
748 *lbs.* tare.	
4180 *lbs.* neat.	
4180 at 7*d p. lb*	
⅓ 1393 ——	4
¼ 1045 — 0	
2438 ——	4
121*l.* — 18*s.* —	

3. If the price of 1 C neat be given,
gether with the tare, either abſolut
ſo much, or ſo much *per* bag, ban

or C, and the price of C's groſs are required: then divide the total number of *l's* tare by 112 to bring them into hundreds; And ſubſtract them from the hundreds groſs, and the remainder will be C's neat, whereof finde the price by the former rules.

Example.

20 C. groſs, tare 9*l. p.* C. at 18*s. p.* C. neat.

20
9
68 tare 180*lb.*
18~~0~~ C. *qu. lb.*
~~112~~ (1—2—12
C. *qu. lb.*
20—0—0 groſs
1—2—12 tare
18—1—16 neat
C. qu. lb.
18-1-16 at 18*s p.* C
18
144
18
324*s.*

12 C. groſs, tare 10 *lb. p.* C. at 9*s. p.* C. neat.

8 C. lb. 2 C.
~~120~~ (1—8—10.
~~112~~ tare 120 lb.
C. qu. lb.
12—00—10 groſs
1—00—08 tare.
11—3—20 neat
11 C.—3 qu.—20 lb. at 9*s. p.* C. neat.
11 C.
9
99 *s.*

324*s.*	99*s.*
$\frac{1}{4}$ C is ——— 4 - 6*d*	then for 2
14 lb. is $\frac{1}{2}$ of	qu. take $\frac{1}{2}$
the last sum	the given
viz. ——— 2 — 3	price *viz.* — 04 - 6
then 2 lb. re-	and for 1
maining of	*qu.* take $\frac{1}{2}$
the 16 lb. is	that *viz.* — 02 — 3
$\frac{1}{7}$ of the last	for 14 *l.*
sum *viz.* — 0 3 - 3	take $\frac{1}{2}$ that
sum of *l.* *s.* *d* *f*	sum *viz.* — 01 - 1 - 2
is 33 1 - 00 - 3	and for 6*l.*
16*l.* - 11*s.* - 00 - 3	remaining
	take $\frac{1}{7}$ of
	the last sum
	viz. ——— 0 - 5 - 3
	10 | 7 — 4 — 1
	5*l* — 7*s* — 4*d* — 1*f*

4. If the hundreds gross have odd pounds, then consider, if one hundred give so much tare, then a quarter of a C will give a quarter so much tare, and if one quarter give so much, 14 *l.* will give $\frac{1}{2}$ so much, and 7 *l.* will give $\frac{1}{2}$ of that, *&c.*

Example.

Example.

6 C. ½ grofs, tare 8 *lb. p.* C. at 2*s.* 6*d.* *p.* pound neat.

6 C. 6 C.
112 8
12
6 48
6 ½ C. 4
672 lb. tare 52
672
56
728 lbs grofs
52 lbs tare
676 lbs neat
½ 676 at 2 *s* 6*d p. l.*
84 *l.* — 10*s.*

8 C. 2*qu.* 21 *l.* grofs tare 12 *l. per* C. at 4*s. per pound* neat.

8 C.
12
96 *l.*
2 *qu.* — 6
14 *l.* — 1½
7 *l.* — 0¾
104 ½
8 C.
112
896
56
21
973 *lb* grofs
104½ *lb* tare
868½ *lb* neat
868 ½ *l.* at 4 *s p. l.*
¾ 217 *l.* 2 *s.*

Practical Rules for finding the Tare.

1. WHen the tare is 14 *l. per cent.* take the $\frac{1}{8}$ of the pounds groſs, and the quotient will be pounds tare, for 14 is $\frac{1}{8}$ of 112.

2. When the allowance is 16 *l. per cent.* tare, take the $\frac{1}{7}$ of the pounds groſs, the quotient gives pounds tare: for 16 is $\frac{1}{7}$ of 112.

3. Hence, if it be tare 21 *l.* work firſt for 14 *l.* by taking $\frac{1}{8}$ of the pounds groſs, and then for the 7 *l.* remaining take $\frac{1}{7}$ of that ſum.

4. If it be tare 27 *l. per cent.* take $\frac{1}{7}$ of the pounds groſs for 16 *l.* and for the 8 pounds remaining, take $\frac{1}{2}$ of what 16 cometh to.

5. If it be tare 20 *l. per cent.* Firſt work for 16 *l.* and for the 4 *l.* take $\frac{1}{4}$ of that quotient.

And thus by making 14 and 16 your ſtanding Rule, they being aliquote parts of 112, you may finde the tare at any rate *per cent.*

Example.

Example.

20 C. groſſe, tare 16 *l. per cent.* 9*d per* pound neat.

20
112
40
20
20
2240 *lb* groſs
$\frac{1}{7}$ 320 *lb* tare
1920 *lb* neat
1920 *l.* at 9*d p. l.*
$\frac{1}{2}$ 960
480
14410
72 *l.*

16 C. tare, 14 *lb per cent.* at 8*d per pound* neat.

16
112
32
16
16
1792 *lb* groſs
$\frac{1}{8}$ 224 *lb* tare
1568 *lb* neat
1568 *l.* at 8*d p. l.*
$\frac{1}{2}$ 784 *s.*
$\frac{1}{6}$ 261—4*d*
104-5-4*d*
52*l.*--5*s*--4*d*

Tret is an allowance of 4 *l.* in 104 *l.* upon ſeveral ſorts of Commodities;

Example.

Example.

40 C. 2 *qu.* gross tare 14 *lb p. cent.* tret 4 *l. p.* 104 *l.* at 6 *dp.* pound neat.

40 C. — 2 *qu.*
114
80
506
405
4536 *lb* gross
$\frac{1}{8}$ 567 *lb* tare
3962 *subtil lb.*
(1
~~336~~ (7 *lb* tret
~~3969~~ (152 $\frac{17}{26}$
~~2666~~
~~22~~
3969 *subtil lb.*
152 $\frac{17}{26}$ *lb* tret
3816 $\frac{9}{26}$ *lb* neat
3816 $\frac{9}{26}$ at 6 *dp. l.*
$\frac{1}{2}$ 1981 3 — 2 *d.*
95 3 — 2 *d.*

24 C. gross, tare 21 *lb. p. cent* tret 4 *lb. p.* 104 *lb.* at 8 *d. p. lb.* neat.

24
112
48
24
24
2688 *lb* gross
$\frac{1}{8}$ 336
$\frac{1}{2}$ 168
504 *lb* tare
2184 *subtil lb*
00 tret
~~2184~~ (84 *lb*
~~266~~
~~2~~
2184 *subtil lb.*
84 tret
2100 *lb.* neat
2100 *l.* at 8 *d p. lb*
$\frac{1}{2}$ 1050 *s.*
$\frac{1}{6}$ 175
1225
61 *lb.* — 5 *s.*

11 When

11. When the price of an integer consists of pounds, shillings and pence, and the price of a number of integers which exceeds not a single figure is requir'd, work as in the following Example.

If 1 *yd.* cost 5*l.* 3*s.* 4*d.* $\frac{1}{2}$ what will 8*yds.* cost.

yd	*l*	*s*	*d*	
1	5	3	$+\frac{1}{2}$	8
	l	*s*	8 *d*	
	41	7	00	

I multiply the price by 8 beginning at the least name thus, 8 half pence is 4 *d*, and 8 times 4 *d* is 32 *d* both make 36 *d* or 3 *s*, which I bear in minde and set down a cipher in the place of pence: then 8 times 3 *s* is 24 *s* and 3 *s* that I did bear in minde is 27 *s*, or 1 *l.* 7*s*, I write down the 7 *s* and bear 1 *l* in minde; then 8 times 5 is 40 *l* and 1 is 41 *l.* which I set down, and the whole price is 41 *l.* 7 *s.*

12. When the price of 1 *l.* is given, the price of 1 C. or 1 12 *l.* may be speedily found in this manner; finde the number of farthings contained in the given price of 1 *l.* then take twice that number

number of shillings, and once that number of groats, the sum of them gives the value of 1 C. or 112 *l.*

Example.

If 1 *l.* cost 9 farthings what 1 C. *fere*? I take first 18 *s* it being twice 9 *s* and then I take 9 groats or 3 *s* which added to the 18 *s* give 1 *l.* 1 *s* for the value of 1 C.

The Reason of the rule is evident, for if 1 *l.* cost 9 farthings then a 112 *l.* must cost 9 times 112 *f.* but a 112 farthings is twice 48 *f.* or 1 *s* and 16 farthings or 1 groat, therefore 112 *l.* will cost twice 9 *s* and once 9 groats, wherefore the rule is true.

CHAP. XV.

The Double Golden Rule.

WHen there are more than 3 terms propounded, then is the question to be resolved by the compound Golden Rule.

Under

Under the compound Golden Rule is comprehended the double Rule of 3, and divers Rules of plural proportion.

The double Rule, is when 5 numbers being given, a sixth proportional unto them is fonnd by two single rules of 3.

Of the 5 given numbers, 3 imply a suppoſition, and two move a queſtion, as in this Example.

If 6 Mowers will mow 54 Acres in 6 days, how many mowers will mow 324 Acres in 9 days? the suppoſition is, if 6 mowers mow 54 Acres in 6 days, and the queſtion is how many mowers will mow 324 Acres in 9 days?

Here for ranking the terms, obſerve amongſt the terms of ſuppoſition which of them is of the ſame name with the number ſought, and place that term in the ſecond or midle place, and write the other two terms of ſuppoſition one above another in the firſt place, and laſtly the terms of demand one above another in the third place; in ſuch ſort that the uppermoſt may have the ſame denomination with the uppermoſt

uppermost in the first place: thus then will the terms in the Example be ordered.

Acres	*Mowers*	*Acres.*
54	6	324
days 6		9 days.

Having ranked the terms, as is taught, you may resolve the question by two single Rules of three, thus.

Say first, If 54 Acres be mowed down by 6 mowers in 6 days, how many mowers will mow down 324 acres in the same time? work by the single Rule of three, as is taught in the 13 Chap. and you will finde that 36 mowers will do it.

Then say again if in 6 days 36 mowers can mow down 324 Acres, how many mowers will do it in 9 days? work (as is taught) by the Rule of 3, and you will finde that 24 mowers, can mow down 324 Acres in 9 days; see the work.

1. *Rule.* *Acres* *Mowers* *Acres*

54——6——324

6

1944

~~8~~~~2~~0

~~1~~~~9~~~~4~~~~4~~ (36 *mowers*

~~5~~~~4~~~~4~~

~~5~~

2. *Rule.* 6 *days*—36 *Mowers*—9*days*.

~~8~~ 6

~~2~~~~1~~~~6~~ (2~~4~~ *mowers* 216

~~9~~~~9~~

The same question, as likewise all others belonging to this rule may be more speedily resolved by one operation of the Rule of three, thus.

Having rank'd the terms (as is taught in the beginning of this Chapter) finde the divisor in the first Rule of 3, which in our Example was 54, then supposing the 4th number in the first Rule of 3 to be known, and using it as the second term in the second Rule of 3, finde also the divisor in the second Rule of three, which in the Example was found to be 9, thus having found the divisor in both Rules of three, multiply them one by the other, and

set

ſet down that product for a diviſor; as alſo multiply the 3 remaining numbers continually one into another, and take their product for a dividend, then finiſh diviſion, and the quotient gives the number ſought: and this method of reſolving queſtions is by Arithmeticians called the Compound Rule of five numbers.

Example.

If the Carriage of 54 C weight 80 miles coſt 12 *l.* what will the Carriage of 27 C. weight 45 miles coſt?

C.	*l*	*C*
54	12	27
80		45

Here for diſcovery of the diviſors in both rules of three: I ſay firſt, if 45 C carried 80 miles coſt 12 *l.* what will 27 C weight coſt being carried the ſame number of miles? it will certainly coſt leſſe; wherefore the greater extream, *viz.* 54 is the diviſor in the firſt Rule of three. Again, I ſay, if the carriage of 27 C weight, 80 miles, coſt a certain number of pounds, how much

much will the carriage of it 45 miles cost? it will cost less; wherefore the greater extream, *viz.* 80 is the divisor in the second Rule of 3, thus having found the divisors, I work as is taught and finde the 4th number to be 3 *l.* 7 *s.* 6*d.* see the work.

```
d. 54——14——27
   80————45
 ————————————
 4320      135
          108
          ————
          1215
            12
          ————
          2430
         1215
         ————
         14580
```

(162
~~1458~~|0 (3 *l.* $\frac{162}{432}$|$\frac{71}{216}$|$\frac{9}{27}$|$\frac{3}{8}$
~~432~~|0

the Carriage will cost 3*l.*-7*s.*-6*d.*

If

If 9 Clerks can write 162 sheets in 6 days, how many Clerks can write 1134 sheets in 14 days?

d.	*sheets*	*Clarks*	*sheets*
	162	2	1134
days.	6		14 *days.*
162			1134
14			9
648			10206
162			6
2266 *divis.*			61236 *divid.*

61236(27 Clerks.

If

If 100 *l.* in 3 years gain 18 *l.* in what time will 340 *l.* gain 50 *l.* at the same rate of Interest?

l.	*years*	*l.*
100	3	340
d. 18		50

50	340
3	18
150	2720
100	340
15000 *divid.*	6120 *divis.*

276
15000|0 (2 years 276|93
6120|206

What principal gained 120 *l.* in 18 moneths when 100 *l.* gains 6 *l* in 12 moneths?

Answ. 1333 $\frac{1}{3}$ *l.* principle.

If 20 men work 120 Rood in 6 days in how many days will 12 men work 54 Rood?

Answ. 4 $\frac{1}{2}$ days.

What principal gained 50 *l.* in 3 moneths, when 100 *l.* gains 4 *l.* in 8 moneths?

Answ. 3333 $\frac{1}{3}$ *l.*

If

If 14 ſtudents ſpend 19 *ls.* in 14 weeks, how much will 19 ſtudents ſpend in 25 weeks?

Anſw. 46 *l.* —— 20 *s* —— 11 $\frac{1}{49}$ *d.*

In what time was 100 *l.* gained of 840 *l.* when 200 *l.* gains 12 *l.* in 12 moneths?

Anſw. 23 $\frac{17}{21}$ moneths.

Note, After you have diſcovered your diviſors, if any of them be equal to any of the numbers remaining, you may abbreviate your work by omitting or cancelling them, and working only with the other diviſor and the other numbers: thus in the laſt Example you will finde the diviſors to be 840 and 12: now becauſe one of the other numbers is alſo 12, cancel them both; and multiply 200 by 100 and divide by 840.

CHAP. XVI.

CHAP. XVI.

Of Exchange.

AFter I have explained the nature of the Rule of three & shew'd the manner of resolving questions by it, I come next to treat of its more particular use in trade under several heads, where first of its use in exchanging of weights, Coins, Measures, *&c.*

In the Exchanging of quantities of divers kinds such as Coins weights, *&c.* it is necessary that the rate or proportions of the quantitie to be exchang'd, be first known from some good Author or rather by experience, and then, it will not be difficult for such as understand the Rule of 3 to know how to exchange a given quantity of one kinde for a quantity of the same value in another kinde: But because the ordinary way of working may be much abbreviated, I shall, propose the most easiest and expedite method, for resolving all questions concerning Exchange.

In

In queſtions concerning exchanging of Coins, weights, *&c.* When two things of different kinds are compar'd together the queſtion may be reſolv'd by one ſingle Rule of three as will appear in the following Examples.

If 100 Ells of *Antwerp* make 75 yards of *London*, how many yards of *London* meaſure will 27 ells of *Antwerp* make? ſay.

If 100 give 75 what 27

facit 20 $\frac{1}{4}$ yards.

A Merchant receiv'd a bill of 700 Crowns at 5 *s* $\frac{1}{3}$ *ſterl.* I demand the ſum in ſterling money, ſay.

If 1 be——5 *s* $\frac{1}{3}$ what 700.

facit 186 *l.*——13 *s.*——4 *d.*

How many dollars at 4 *s* 6 *d* ought to be received for 140 *l. Sterl*: ſay,

If 54 *d* give——1——what 33600 *d.*

facit 622 dolls——12 *d.*

If 100 *l.* of Averdupois weight at *London*, be equal to 89 *l.* at *Paris*, how many *ls.* of *Paris* weight are equal to 340 *l.* of Averdupois weight at *London*? ſay.

If 100 *l.*——89 *l.* what 340 *l.*

facit 302 *l.* $\frac{2}{3}$.

The

The queſtions of this nature are ſo eaſily reſolvable, that *I* think I need not propound any more, but ſhall proceed to thoſe where more than two quantitie are compared together.

In queſtions where one kinde of Coin, weight, or, *&c* is compared with a ſecond of another kinde, and that ſecond with a third, and that third with a fourth, *&c*. it is either required to know.

1. How many pieces of the firſt Coin are equal in value to a given number of pieces of the laſt Coin? or,

2. How many pieces of the laſt Coin are equal in value to a given number of pieces of the firſt Coin?

An Example of the firſt caſe. –

If 27 ells of *Amſterdam* are equal to 16 ells of *Lyons*, and 3 ells of *Lyons* are equal to 5 ells of *Antwerp*, and 4 ells of *Antwerp* are equal to 5 ells of *Cologne*; to know how many ells of *Amſterdam* are contained in 200 ells of *Cologne*,

Rank the number as in the following example, obſerving in the examples of the firſt caſe to place the laſt number

number under the first Columne.

	Amst.	*Lyons*
	27	16
Ly.	3	5 *Antw.*
Ant.	4	5 *Col.*
	200	400 *divis.*
	64800 *divid.*	

20
648|00|(162
444|00|

Having thus ranked them Multiply all the numbers of the first Columne continually, and take their product for a dividend; then multiply all the nnmbers in the second Columne continually and take their product for a divisor; then finish division by it, and the quotient gives the number sought; which in the example you will finde to be 162.

An Example of the latter case.

If 7*l.* of Sugar be worth 2*l.* of Cloves, and 3 *l.* of Cloves be worth 13 *l.* of pepper, and 1 *l.* of pepper be worth 12 *d*, what will a Chest of sugar cost weighing 476 *l.*

Here

Here rank the numbers in two Columns, as before, but the last number must be put under the second Column.

	Sugar	*Cloves*
	7	2
C.	3	13 *Pepper.*
P.	1	12 *d.*
21 *divis.*		476
		148512 *divid.*

14
148512 (7072 *d.*
xxxxx
xxx

Then Multiply all the numbers in the first Column continually, and take their product for a divisor, likewise multiply the numbers in the second Column continually, and take their product for a dividend; lastly, finish division, and the quotient is the number sought, *viz.* 7072*d.* or 2*l.* 9*s.* 4*d.*

The same questions may be severally resolved by 3 single Rules of 3, from whence the reason of the Rule will be manifest: thus then may the first question be resolved.

1. If 16 ells of *Lyons* be equal to 2 ells of *Amſterdam*, how many ells of *Amſterdam* are equal to 3 ells of *Lyons*?

facit $5\frac{1}{16}$ *Ells.*

Now becauſe 3 ells of *Lyons* are in the queſtion ſuppoſed equal to 5 ells of *Antwerp*, ſay again,

2. If 5 ells of *Antwerp* be equal to $5\frac{7}{16}$ ells of *Amſterdam*, how many ells of *Amſterdam*, are equal to 4 ells of *Antwerp*.

facit. $4\frac{1}{20}$ *Ells.*

Now becauſe 4 ells of *Antwerp* are in the queſtion ſuppoſed equal to 5 ells of *Cologne*, ſay,

3. If 5 ells of *Cologne* be equal to $\frac{1}{20}$ ells of *Amſterdam*, how many ells of *Amſterdam*, are equal to 200 ells of *Cologne*?

facit. 162 *ells*

The ſecond queſtion may be thus reſolved.

If 2 *l.* of Cloves be worth 7 *l.* of Sugar how many *l.* of Sugar are 3 *l.* of Cloves worth?

facit. $10\frac{1}{2}$ *lb.*

Then becauſe 3 *lb.* of Cloves is equal

qual to 13 *l.* of pepper, say,

If 13 *l.* of pepper be worth 10 $\frac{1}{2}$ *l.* of Sugar, how much is 1 *l.* worth?

facit. $\frac{21}{26}$ *l.*

Then because 1 *l.* of pepper is worth 12 *d.* say,

If $\frac{21}{26}$ *l.* of Sugar cost 12 *d.* what will 476 *l.* cost?

facit. 7072 *d.* or 29 *l.*—9 *s.*—4 *d.*

The following Scheme of the resolution of these questions by 3 single Rules of three, does exhibit the very Rule before expresst in words.

Note, for the better understanding of the Scheme, that this character (=) signifies equallity, this (x) multiplication, and numbers thus placed $\frac{36}{4}$ import division, *viz.* that 36 is to be divided by 4.

I. *Quest.*

1. If 16 *L.* 27 *A*:: 3 *L.* $\frac{27 \times 3}{16}$

2. If 5 *An.* $\frac{27 \times 2}{16}$:: 4 *Ant.* $\frac{27 \times 3 \times 4}{16 \times 5}$

3. If 5 *Col.* $\frac{27 \times 3 \times 4}{16 \times 5}$:: 200 *col.* $\frac{27 \times 3 \times 4 \times 200}{16 \times 5 \times 5}$

And this last 4th number discovers the first rule.

Queſt. II.

1. If 2 *Cl.* 7 *S* :: 3 *Cl.* $\frac{7 \times 3}{2}$

2. If 13 p. $\frac{7 \times 3}{2}$ :: 1 p. $\frac{7 \times 3 \times 1}{13 \times 2}$

3. If $\frac{7 \times 3 \times 1}{13 \times 2}$ 12 :: 476. $\frac{13 \times 2 \times 12 \times 476}{7 \times 3 \times 1}$

Which laſt fourth number gives the ſecond rule.

Note, when in reſolving ſuch queſtions, by the Rules aforeſaid the ſame numbers happen to be multiplicators in the dividend, and alſo in the diviſor ſuch multiplicators may be cancell'd in both, and thereby your work may be oftentimes much abbreviated.

Queſtions for practice of the preceding Rules.

If 4 ells of *Antwerp* meaſure make 3 yards of *London* meaſure, and 15 yards of *London* meaſure, make 12 ells of *Lyons* meaſure, how many ells of *Antwerp* meaſure are contain'd in 60 ells of *Lyons* meaſure?

facit 100.

If 15 french Alnuds make a 100 ſtick

ſticks flemiſh, and a 100 ſticks flemiſh, make 60 Engliſh ells, how many Alnuds is 150 Engliſh ells?

facit 37 ½.

CHAP XVII.

Of Barter.

BArter is the Exchanging of one Commodity for another.

How much tobacco at 3 *l. per* C. muſt be bartered for 1800 *l.* of Sugar at 8*d per l*?

If 1 *l.* coſt 8*d* what 1800 *l. facit* 60*l.* then if 3*l* buy 1 C. what 60*l. facit* 20 C.

How much tallow at 38 *s per* C. muſt be given for 30 dozen of Candels at 4 *s* 6 *d per* dozen?

Anſwer 3 C $\frac{21}{38}$.

A. hath 80 pieces of ſilks, which are worth but 3 *l. per* piece in ready money, yet he barters them with B. at 4 *l. per* piece for wools at 7 *l.* 10 *s per* C. which are worth but 6 *l.* in ready money, the queſtion is now, what quantity of wools pays for the Silks, and which of the two is the gainer, and how much?

Anſ. 42 $\frac{2}{3}$ C. of wools pay for the ſilks and *A* gained 16 *l.* by the barter.

Nutmegs at 4*s* 6*d per l.* ready money, and 5*s* 4*d* in barter, how muſt ginger of 15 4*d per l.* be ſold to make like profit?

Anſwer 18 *d* 3 *f.* $\frac{22}{27}$.

CHAP. XVIII.

Of Factorſhip.

A Merchant delivereth to his factor 100 *l.* to be imployed in traſick, and by Agreement between them, the factors ſervice, is eſtimated equivalent, to a certain ſtock, which is ſuch, that if the gain be proportionably divided according to thoſe two ſtocks, the factor is to receive $\frac{3}{16}$ of the gain, I demand what the factors ſervice was worth?

The factors part of the gain being $\frac{3}{16}$ the Merchant's muſt be $\frac{13}{16}$, wherefore ſay,

If $\frac{13}{16}$ give 100 *l.* what $\frac{3}{16}$ *facit* 24. $\frac{3}{26}$.

A Merchant delivereth to his factor 600 *l.* and permitteth him to adde thereunto 100 *l.* of his own money to be imployed in traffick, and by agreement between them, the factors ſervice.

vice is estimated equivalent to a certain stock, which is such, that if the whole gain be proportionably divided in respect of those 3 stocks, that the factor shall receive $\frac{1}{7}$ of the gain in consideration of that imaginary stock; the question is, what is the value of the factors service, and the share of the gain that belonged to each of them?

Adde to 600 *l.* the factors 100 *l.* and say,

If $\frac{6}{7}$ give 700 *l.* what $\frac{1}{7}$? *facit* $116\frac{2}{3}$

then adde all the 3 stocks together, 600 + 100 + $116\frac{2}{3}$ = $816\frac{2}{3}$

then say,

If $816\frac{2}{3}$ give 1 what 600 | $\frac{14}{49}$ *facit* $216\frac{2}{3}$ | $\frac{11}{49}$.

CHAP. XIX.

The Rule of Fellowship.

THe Rule teacheth to divide a given number, into parts proportional to given numbers, it has its name

from societies amongst Merchants; unto whom it is most useful.

The gain or loss being known, together with the particular stocks of the Merchants entered in company, the proportional part of yards known gain or loss that is due to every Merchant may be found by one of these 3 ways following.

First, if the Merchants entred in company, have laid in equal stocks into the common bank, then their particular shares of the gain or loss may be found, by dividing the gain or loss by the number of Merchants.

Secondly, if the Merchants have laid in unequal stocks, but have let them continue an equal time, then the particular share of the gain are thus found, by this first part of this Rule, which Arithmeticians commonly calls *Fellowship without time, viz.*

Adde all the particulars together, and let their sum be alwayes the first number in the *Rule of three*: Let the gain or loss be the second and each man's particular stock the third, and use so many *Rules of three* as there are stocks,

ſtocks, the 4th numbers are the particular ſhares of the gain or loſs requir'd.

Examples.

Three Merchants *A. B.* and *C.* entred in Company, *A* brought 80 *l.* *B* 70 *l.* and *C* 140 *l.* And at the end of a year, they found they had gained 100 *l.* the queſtion is, what was each man's particular ſhare of that gain? which finde thus,

A —— 80 *l.*
B —— 70
C —— 140
ſum —— 290

Sum of ſtocks, gain, ſtock *l.* *A.*
1. If 290 *l.* —— 100 *l.* —— 80 *facit* 27 $\frac{12}{29}$
B.
2. If 290 —— 100 —— 70 *facit* 24 $\frac{4}{29}$
C.
3. If 290 —— 100 —— 140 *facit* 48 $\frac{8}{29}$
for proof ſum —— 100 *l.* gain

the ſum of the ſhares give the gain.

Three Merchants entred in company, *A. B. C. A* and *B* together

brought 540 *l.* *B* and *C* together brought 360*l.* and *A* and *C* together brought 450*l.* at the end of 6 moneths they gave over trading, and found they had gained in that time 150*l.* the question is, how much did each merchant bring into the common ſtock? and what is each mans ſhare of the gain?

do thus,

A and *B* —— 540*l.*
B and *C* —— 363
C and *A* —— 450
ſum 1354 is the double of their ſtocks

Sum of their ſtocks 675
ſubſtract the ſtocks
of *B* and *C* —— 360
the remainder is 315 the ſtock of *A* which ſtock ſubſtract from 540, and there will remain the ſtock of *B*. *viz.* 225*l.* Laſtly ſubſtract the ſtock of *B* from 360. and there will remain the ſtock of *C*. *viz.* 135. the ſtocks being found, work as in the former queſtion.

Sum of stocks, gain *l.* *A.* *l.*

1. If 675 —— 150 —— 315 —— 70

B.

2. If 175 —— 150 —— 225 *facit* 50

C.

3. If 657 —— 150 —— 135 —— 30

sum —— 150*l.* gain

Thirdly, if the Merchants have brought in unequal stocks, and have let them continue unequal times, then, must each mans share of the gain be proportional both to his stock and the time of its continuance in the common bank, which may be thus found by this second part of the Rule (which Arithmeticians call the *Double Rule of Fellowship*, or *Fellowship with time*.) viz.

Multiply each mans stock by the time of its continuance in the common bank, then add all these products together, and let their sum be always the first number in every Rule of 3, let the total gain or loss be the second and the product of each mans stock multiplied by its time the third; And use so many Rules of 3 as there are particular stocks, the 4th numbers will give the

brought 540 *l.* *B* and *C* together brought 360*l.* and *A* and *C* together brought 450*l.* at the end of 6 moneths they gave over trading, and found they had gained in that time 150*l.* the question is, how much did each merchant bring into the common stock? and what is each mans share of the gain? do thus,

A and *B*	540*l.*
B and *C*	363
C and *A*	450
sum	1354 is the double of their stocks

Sum of their stocks 675
substract the stocks of *B* and *C* 360
the remainder is 315 the stock of *A* which stock substract from 540, and there will remain the stock of *B*. *viz.* 225*l.* Lastly substract the stock of *B* from 360. and there will remain the stock of *C*. *viz.* 135. the stocks being found, work as in the former question.

Sum

Sum of stocks.	gain *l.*	*A.*	*l.*
1. If 675	150	315	70
		B.	
2. If 175	150	225	*facit* 50
		C.	
3. If 657	150	135	30
sum	150 *l.*	gain	

Thirdly, if the Merchants have brought in unequal ſtocks, and have let them continue unequal times, then muſt each mans ſhare of the gain be proportional both to his ſtock and the time of its continuance in the common bank, which may be thus found by this ſecond part of the Rule (which Arithmeticians call the *Double Rule of Fellowſhip*, or *Fellowſhip with time.*) *viz.*

Multiply each mans ſtock by the time of its continuance in the common bank, then add all theſe products together, and let their ſum be always the firſt number in every Rule of 3, let the total gain or loſs be the ſecond and the product of each mans ſtock multiplied by its time the third; And uſe ſo many Rules of 3 as there are particular ſtocks, the 4th numbers will give

the

the particular ſhares of the gain or loſs: as in the following examples.

Four Merchants enter partnerſhip, viz. *A. B. C.* and *D.* and agree to continue in a joint adventure 12 moneths: *A* puts into the common ſtock at the beginning of the ſaid term, 100*l.* and at the end of 10 months takes out 40*l.* and permits the reſt to continue the reſt of the time. *B* puts in at firſt 150*l.* and at the end of 6 moneths takes out 80*l.* and 2 moneths after that he puts in 100*l.* and permits all to continue to the end of the time: *C.* puts in at firſt 80*l.* and at the end of 8 moneths, he puts in 80*l.* more, and permits all to continue to the end of the time. *D.* puts in at firſt 160*l.* and at the end of 4 moneths he takes out 100*l.* and at the end of 5 moneths after that, he puts in 200*l.* and permits all to continue till the end of the time of partnerſhip; at which time they finde they had gain'd 350*l.* the queſtion is, what is each mans ſhare of the gain? here obſerve diligently that the whole time of partnerſhip was 12 moneths, and the particular times of the continuance of the

particular

particular ſtocks is as followeth.

A——100*l* for 10 mon. *facit* 1000
ſubſtract 40
Remains 60 for 2 mon. *facit* 120
ſtock of *A* multiplied by the time of its continuance. 1120

B——150*l*. for 6 mon. *facit* 900
ſubſtract 80
Remains 70 for 2 mon. *facit* 140
Add 100
ſum 170 for 4 mon. *facit* 680
ſtock of *B* multiplied &c.—— 1720

C 80*l*. for 8 mon. *facit*—— 640
Add 80
ſum 160 for 4 mon. *facit*—— 640
ſtock of *C* multipl. &c. 1280

D——160*l*. for 4 mon. *facit*—— 640
ſubſtr. 100
Remains 60 for 5 mon. *facit*—— 300
Add 200
ſum 260 for 3 mon. *facit*—— 780

ſtock of *D* mult. &c. 1720

thus

thus the particular ſtocks of the Merchants multiplied by their times are as followeth.

A	1120*l.*
B	1720
C	1280
D	1720
ſum	5840

	ſum &c.	gain	*A facit*
1. If	5840	350 — 1120	67 $\frac{22}{73}$
		B	
2. If	5840	350 — 1720	103 $\frac{6}{73}$
		C	
3. If	5840	350 — 1280	76 $\frac{52}{73}$
		D	
4. If	5840	350 — 1720	103 $\frac{6}{73}$
	ſum		350 gain

Two Merchants *A* and *B* have entred company, *A* puts in 500*l.* and at the end of 4 moneths he takes out a certain ſum, and leaves the reſt to continue 8 mon. longer; *B.* puts in 250*l.* and at 5 moneths end, he puts in 300*l.* more, & then his whole ſum continues ſeven moneths longer. Now at the making of their accompts, *A* findeth he hath gained

ed 106 $\frac{2}{3}$ *l.* and *B* gained 133 $\frac{1}{3}$ *l.* the queſtion is, how much *A* took out of the ſtock?

B 250*l.* for 5 Moneths *facit* 1250*l.*
adde 300

ſum 550 for 7 mon. *facit* —— 3850

ſum 5100

gain	ſtock	gain	ſtock
If 133 $\frac{1}{3}$ ——	5100 ——	106 $\frac{2}{3}$ *facit*	4080

from which ſubſtract
500 for 4 mon, *viz.* —— 3000
2080

which divide by 8 mon. the quotient is 260 the money remaining, which ſubſtract from 500, the remainder is 240, the money taken out by *A*.

Three Butchers hired a piece of paſture ground for 15 *l.* 10 *s.* *A* put in 9 oxen for 14 days, *B* put in 20 oxen for 7 days, and *C* put in 15 oxen for 8 days: the queſtion is how much each butcher ought to pay?

	oxen	*days*	
A put in	9	for 14 ——	126
B put in	20	for 7 ——	140
C put in	15	for 8 ——	120
			386

If

If 386-15*l.*-10*s*-126 *fac.* 5*l.*-1*s*-2*d* &c.
If 386--15--10--140 *fac.* 5*l.*-12*s*-5*d* &c.
If 386--15--10--120 *fac.* 4*l.*-16*s*-4*d* &c.

15-10-0

the Rule of fellowship is proved by additions of the 4th numbers found; for if their sum be equal to the second number, the work is true, if it be not equal the work is erroneous: so in the last example the 4th numbers, *viz.* 5*l.* 1*s.* 2*d.* † 5*l.* 12*s.* 5*d.* † 4*l* 16*s.* 4*d* † being added together, make 15*l.* 10*s.* the second term.

CHAP. XX.

The Rule of Alligation.

THe *Rule of Alligation* teacheth to resolve Questions concerning the mixing of diverse simples together.

Alligation is either medial or alternate.

Alligation medial, is when having the several quantities and rates of divers.

vers simples propounded, we discover the mean rate of a mixture compounded of those simples.

Thus if a Tobacconist were to mix 8 *l.* of tobacco of 2 *s* the pound with 5 *l* of tobacco of 3*s* the pound; 6 *l.* of tobacco of 6 *s* the pound with 4 *l.* of tobacco of 7 *s* the pound, the rule of Alligation medial sheweth you the mean price of 1 *l.* of that mistling, thus.

Sum up the given quantities, and finde the total value of all the simples they say by the Rule of Three; as the sum of the quantities, is to the total value of the simples, so is any part of the mixture propounded to the required mean rate or price of that part.

See the resolution of the question according to the rule.

8 *l.* of tobacco at 2 *s* the pound	is	16 *s*
5 of tobacco at 3 *s*	is	15 *s*
6 at 6 *s*	is	36 *s*
4 at 7 *s*	is	28 *s*
15 *l.* sum of the quantities.		95 *s*

total value of the simples

If 15 *l.* be worth 95 *s.* what 1 *l. fac.* 6 *s* 4 *d.*

For proof of this Rule: finde the value of the whole mixture according to

to the mean price found, and if that sum be equal to the total value of the simples, the operation is perfect, otherwise not: thus then will the last operation be proved:

The total value of the simples was found to be 95 *s* or 4 *l.* 15 *s*, which is likewise the value of 15 *l.* 6 *s* 4 *d per.* pound.

Alligation Alternate is, when having the rates of divers simples, we discover such quantities of them, as are necessary to make a mixture, which may bear a certain rate propounded.

Example, a Vintner determines to mix 20 Gallons of wine of 15 *d* a Gallon, with other sorts of wine of several prices, *viz.* with some of 16 *d* a Gallon, and some of 18 *d* a Gallon, and some of 22 *d* a Gallon. now the *Rule of Alligation Alternate*, will discover, how many Gallons of each sort he must take to make one gallon of that mixture worth 17 *d*?

In questions of Alligation alternate, first set down the mean rate or price propounded on the left hand, and the given rates on the right hand orderly under one another. Secondly,

Secondly link the numbers placed on the right hand together by an arch, in such sort, that one that is greater than the mean rate, may be link'd to one that is less than the mean rate: so will the numbers in the example be placed and link'd, as in the Example.

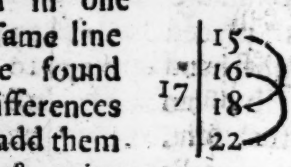
	d.	15*d*
	17	16
		18
		22

Thirdly, having alligated the numbers, finde the difference betwixt the numbers and the mean rate, and write the difference of each number just against the number that is coupled with it; When one number is linked to divers other numbers, the differences ought to be as often transcribed, as it is so diversly linked, so in the Example you may link the numbers, as in the example.

		15	5
	17	16	1
		18	1
		22	2

When

When in one and the same line there are found more differences than one add them together, & write the sum just against the same differences, having first drawn a line,



Alligation Alternate is either partial or total.

Alternation partial is, when having the several rates of divers simples together with the quantity of one of them given: we discover the quantities of the rest which are necessary to make a mixture, together with the quantity given which may bear a certain rate propounded: and of this kinde is the Example last propounded.

In questions of Alternation partial the proportion is.

As the difference annexed to the first number is to the several differences annexed to the rest, so is the quantity propounded to the several quantities required; so will the last question be resolved by 3 Rules of 3, thus.

1. As 5 the difference annexed to the

the first number is to 1, the difference annexed to the second, so is 20 the given quantity of the first sort of wine, to 4 the quantity to be taken of the second sort of wine.

2. As 5 to 1 so is 20 to 4 the quantity to be taken of the 3*d* sort.

3. As 5 to 2, so is 20 to 8, the quantity to be taken of the 4th sort of wine, so that at last I conclude, if with the 20 Gallons of wine at 15*d* a Gallon, you mixt 4 Gallons of wine at 16*d* a Gallon, 4 Gallons of wine at 18*d* a Gallon, and 8 Gallons of wine at 22*d* a gallon, 1 gallon of that mixture may be sold for 17*d*.

The same example being ordered after the second manner may be thus wrought.

1. As 6 the sum of the differences annexed to the first number is to 20 the quantity given of the first simple, so is 6 the difference annexed to the second number to the same quantity to be taken of the second simple.

2. As 6 to 3, so 20 to 10, the quantity to be taken of the third simple.

3. As 6 to 3, so 20 to the quantity

to

to be taken of the 4th ſimple; ſo at laſt I conclude, that if 20 gallons of wine of 15*d* a gallon be mixed with 20 gallons of wine of 16*d* a gallon, and 10 gallons of wine of 18*d* a gallon, and 10 gallons of wine of 22*d* a gallon, one gallon of that mixture may be ſold for 17*d* as before.

The proof of this Rule, is by comparing the total value of the ſeveral ſimples with the value of the whole mixture: ſo in the Example propounded; if reſolved after the firſt manner.

20 Gallons at 15*d* a Gallon	is	300*d*
4 at 16	is	64
4 at 18	is	72
8 at 22	is	176
36 total value	is	612*d*

36 Gallons at 17*d* a Gallon is 612*d*.

36
17
252
36
612

the

the proof of the Example if wrought the second way.

20 Gall. at 15*d* a Gallon		is	300
20 Gall. at 16		is	320
10	at 18	is	180
10	at 22	is	220
			1020

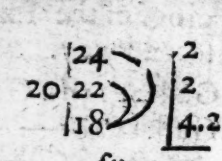
60 Gallons at 17*d* a Gallon amounts also to 1020*d*.

Alternation total is, when having the total quantity of all the simples together, with their several rates, we produce their several quantities, in such sort that a mixture of them being made according to the quantities so found, that mixture may bear a certain rate propounded.

Example, *A* Goldsmith hath some Gold of 24 Carects fine, others of 22 carects, and another sort of 18 carects, fine, he would so mix these together that the mixed mass might be 60*l*, and that the whole mixture might bear 20 carects fine: now the *Rule of Alternation total*, teacheth how much of each sort he must take.

In questions of this Rule, Alligate or link

link the numbers, & find the differences, as is taught; then adde the differences, and let their sum be the first number in the Rule of three, let the total quantity of the simples be the second, and each difference the third, and 4th numbers will give the quantities required, so will the Example be thus wrought.



1. As 10 the sum of the differences is to 60 *l.* the sum of the quantities, so is 2 the difference annexed to the first number to 12 the quantity to be taken of the first fineness.

2. As 10 to 60 so 2 to 12 the quantity to be taken of the second fineneſſe.

3. As 10 to 60 so 6 to 36 the quantity to be taken of the 3d fineneſſe.

So I conclude, if he take 12 *l.* of 24 Carects fine, 12 *l.* of 22 Carects fine, and 36 *l.* of 18 Carects fine, then that mass will bear 20 Carects fine.

For proof of this Rule, adde all the quantities found together, and if their sum agree with the sum of the quanti-

ties

ties propounded, the work is perfect; so in the Example 12 12 and 36, the quantities found amount to 60, wherefore the work is true.

CHAP. XXI.

The Rule of False Position.

THe Rule of False Position teacheth by false and supposititial numbers taken at pleasure, to discover the true terms required.

The *Rule of False* is either of single or double position.

The *Rule of single Position* is when at once, *viz.* by one single position, we discover the true resolution of the question propounded; which is done by this Rule, *viz.*

For the number unknown put any number you please (which shall be called a position or supposition) then examine that number according to the tenour of the question; and if it resolve not the question, place it as the first number in the Rule of 3. put the result

of the working by that false number in the second place, and the number given in the question, in the third place, work by the *Rule of* 3, and the 4th number will be the true number sought.

Hence, these questions only can be resolved by the *Rule of single position* where the number found by the trial of the false number, is to the position, as the number given is to the number sought.

Examples.

The third part of an Army was killed, the 4th part was taken, and 1000 fled, how many were in the Army? how many were killed? and how many were captives?

Suppose the Army consisted of 108 men in all, then there were 36 killed, 27 taken, and 45 fled, but 1000 ought to have fled, wherefore say by the *Rule of* three,

If 45 —— 108 —— 1000. *facit* 2400

whose	$\frac{1}{3}$ is 800 killed
2400	$\frac{1}{4}$ is 600 taken
1400	1400
1000 fled	

Three

Three men together, owe 7000 *l.* the first man owes twice so much as the second, and the second owes a third part lesse than the third; the question is, how much does each of them owe?

suppose the first owes—— 9 *l.*
then the second owes——18
the third owes——27
in all 54

but they owe 7000, wherefore,

If 54—9—7000 *facit* 1166 $\frac{2}{3}$
then the second owes——2333 $\frac{1}{3}$
and the third owes——3500.
sum——7000

To know whether a question propounded may be resolved by the *Rule of single Position* or not.

When you have made a position, if in proceeding with it according to the tenour of the question, you must use some number given in the question, then be sure, that that question cannot be resolved by a single position.

The *Rule of double Position* is when we resolve questions by two positions, in this manner:

First, for the unknown number put

any other (which ſhall be called the firſt poſition) and proceed with it according to the tenour of the queſtion, and if it reſolve not the queſtion, finde the errour, which if it be in exceſs, write it down under the poſition with this ſigne x, but if it be in defect with this —: then make another poſition, and proceed as before, noting the errour under it as is taught, then if the errors be alike (that is both in exceſs, or both in defect) ſubſtract the one from the other, and place the remainder as the firſt number in the Rule of three; but if the errors be unlike (that is one in exceſs, the other in defect) adde them together, and let their ſum be the firſt number in the *Rule of three*; Then ſubſtract the one poſition from the other, and place the remainder as the ſecond, and place either of the errors as the third number in the *Rule of three*: by theſe finde the 4th proportional, and adde it to that poſition, whoſe error was put for the third number in the *Rule of three*, (if that errour was in defect,) but ſubſtract it from the poſition if the errour was in exceſs, the ſum

sum or remainder gives the number sought.

Note, 1. It is convenient to take the least positions you can, even an Unity, if it may be conveniently taken.

2. It is likewise fit to make the second position but one less or more than the first, for so the *Rule of three* may be performed by Division only: And lastly, it is better to neglect the 2 Notes given then to assume a position that may occasion fractions.

Examples.

A shepherd in the time of war driving a flock of sheep fell into the hands of three companies of plundering Soldiers, who compelled him to deliver the half of his flock, with $\frac{1}{2}$ a sheep over to the first company; also $\frac{1}{2}$ of his remaining flock with $\frac{1}{2}$ a sheep to the second company; likewise the $\frac{2}{3}$ of the rest with $\frac{1}{2}$ a sheep to the third company: All which divisions he exactly performed without killing a sheep; and then there remained only 20 sheep to himself: the question is, how many sheep the shepherd had in his flock at first?

First, suppose 11 sheep, then he delivered to the first company —— 6 sheep
And had remaining —— 5
He delivered to the second Company —— 3
And had remaining —— 2 sheep
He delivered to the third Company —— $1\frac{1}{2}$
And had remaining —— $\frac{1}{2}$
But he should have had 20 remaining, wherefore, the errour is (—) $19\frac{1}{2}$ in defect.

Again, suppose he had 13 sheep:
He delivered to the first Company —— 7
And had remaining —— 6
To the second company —— $3\frac{1}{2}$
And had remaining —— $2\frac{1}{2}$
To the third company —— $1\frac{1}{4}$
And had remaining —— $\frac{1}{4}$
Which is less than 20 by $19\frac{11}{44}$ (—)
Wherefore because the errours are alike, subtract the one from the other, the difference is $\frac{11}{44}$.

Then the difference of the positions is 2. wherefore frame the rule of 3 thus.

As $\frac{1}{4}$ the difference of the errours (because they are alike) is to 2 the difference

difference of the positions; so is 19 $\frac{1}{2}$ one of the errours to a 4th, which by the Rule of 3 is found to be 156, to which (because the errour put in the third place of the Rule of 3, was in defect) you must adde the first position, belonging to that errour, the sum 167 is the number sought; for so many sheep the shepherd had at first, which you may prove by examining the number according to the tenour of the question.

A Merchant began to trade with a certain number of pounds, by his first voyage he doubled that stock, by his second he lost 1200*l*, by his third he doubled that remaining stock, by his 4th he lost 1200*l*. and had nothing remaining: the question is, how many pounds the Merchant began to trade with?

Suppose 1000*l*. then by his first voyage he made it —— 2000
By his second —— 800
By his third —— 1600
By his 4th —— 400

But he should have had nothing remaining, wherefore 400 x. is errour in excess.

Again, suppose he had at first 1001 *l.*
Then by his first voyage he made it——————2002
By his second——————802
By his third——————1604
By his 4th——————404
which 404 x is the errour of the second position in excess.

Then frame the *Rule of three* thus.

As 4 the difference of the errours (they being like) to 1 the difference of the positions, so 400 one of the errours to a 4th, which is 100, which (because the errour in the third place of the *Rule of three* was in excess) must be substracted, from the first position belonging to that error, the remainder 900 is the number sought.

Another way of performing the Rule of false by two positions:

After you have examined your 2 positions according to the tenour of the questions, and have noted the errours, Multiply crosswise the first position by the second errour, and the second position by the first errour, noting the products, then if the errours be alike, substract the one product from the other,

as

as also subtract the one errour from the other, and divide the first remainder by the last, the quotient gives the number sought.

If the errours be unlike, divide the sum of the products by the sum of the errours, the quotient gives the number sought.

Two men have each an unknown number of pounds, one says to the other, if you give me 1 *l.* then shall I have twice so many pounds as you have, the other answers, if you give me 1 *l.* then I shall have just so many pounds as you have: the question is, how much each man had?

Suppose the first had 3 *l*, then receiving one pound from the other man, he had 4 *l.* the $\frac{1}{2}$ of which, *viz.* 2 *l*, was the remaining pounds that the other had, wherefore he had at first 3 *l.* also, to which if he add one pound out of the first mans money, then he'l have 4 *l*, and the other will have but 2 *l.* remaining; whereas according to the question he should have as much remaining as he then had: wherefore the first errour in defect is 2——

Again, suppose the first man had 9*l.* then receiving 1*l.* of the other, he had 10*l.*, the $\frac{1}{2}$ of which, *viz.* 5*l.* are the pounds the other had remaining, wherefore he had at first 6*l.*, to which if you add 1*l.* taken from the first man, then he'l have 7*l.*, and the first will have 8*l.* remaining; wherefore the errour in excess is 1*l.* x wherefore by the last Rule I discover the number sought in this manner.

first position 3 X 2—first errour
second position 9 X 1 †second errour

Note, these signs †—signify the first excess, the last defect.

18 3
3
21 sum of the products
3 sum of the errours
7 number sought.

CHAP. XXII.

Notation of Decimal Fractions.

A Decimal number is that which is expressed, by an Unit with a Cipher or Ciphers, as 10 100, 1000, &c.

A

A decimal Fraction is that whose denominator is a decimal number, as $\frac{1}{10}$ $\frac{14}{1000}$, *&c.*

Decimal Fractions whether they ſtand alone or be joined with Integers, have always a comma or point before them, to diſtinguiſh them from Integers, as ,5 ,36 ,005, *&c.*

As in Integers the values or denominations of places do encreaſe by *tenns* from the Units place towards the left hand, ſo in decimals, the values or denominations of places do decreaſe by tenns from the units place towards the right hand according to this table.

Integers								Decimals								
9	8	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	8	9
										tenths	hundreths	thouſandths	tenn thouſandths	hundred thouſandths	millions	tenn millionths	hundred millionths	thouſand millionths
										units								
										tenns								
										hundreds								
										thouſands								
										tenn thouſands								
										hundred thouſands								
										millions								
										tenns of millions								
										hundred millions								
										millions of millions								

In

In decimals the numerators only are written down, without the denominators, but the denominators are easily known, for they are the same with the denomination of the last figure in the numerator, Example

7 is	7 Num.	7
,1	tenths denom.	10
,05	five Num.	5
	hundreths denom.	100
,0068	sixty eight Num.	68
	ten thousandth parts. denom.	10000

Ciphers before integers, and after decimals are of no value, but after integers, and before decimals they have their value, for though they signifie nothing, yet in integers they augment, and in decimals they diminish the value of the other figures joyned with them; As,

0006 is but six	007 but seven
6000 is six thousand:	700 seven hund.
800 is but eight tenths	50 five tenths
,008 is eight thousandth parts	,05 *five hund. parts.*

CHAP.

CHAP. XXIII.

Addition and Subſtraction in Decimals.

ADdition and ſubſtraction whether in pure decimals, or in integers mixt with decimals, differs not from Addition and Subſtraction in integers, only care muſt be had to place the commas, or points of ſeparation under one another, and the ſeparating point in the ſum, and difference muſt be plac'd under the ſeparating lines of the numbers added or ſubſtracted.

Examples,

of Addition.

,345	
,058	
2005	
,406	
l.	
86, 0569	
92, 586	
34, 906	
19, 0053	
232, 5542	

of Subſtraction.

,86503	
,05983	
,80520	
86, 005	
19, 9865	
18, 868	
23, 9864	
23, 641	

CHAP. XXIV.

Multiplication in Decimals.

MUltiplication whether in pure decimals, or in integers and decimals, is the same in operation with Multiplication in integers. The last figures of the numbers to be multiplied must be set under one another as if they were integers, not regarding to place the separating points under one another, as in Addition and Substraction. And from the product cut off with a separating point, so many of the last figures, as there are places of decimals in both the numbers to be multiplied.

Examples.

,64	4,64	5,32
,8	,93	,48
,512	1392	4256
	4176	2128
	4,3152	255,36

If

If it happen when the Multiplication is ended, that there be fewer figures or places in the product than there are places of decimals, in both the numbers multiplied; then put so many ciphers before the product, until the places of decimals may be equal to the number of places of decimals in both multiplying numbers.

Examples.

,3	.0053	.004
,2	.12	16
,06	0106	024
	005	004
	.000636	0.064

If a decimal fraction, or an Integer with a decimal is to be multiplied by a decimal number, remove the separating point so many places towards the right hand, as there are ciphers in the decimal number, As .568 by 10 is 5,68, by 100 is 56. 8, *&c.*

And if the decimal number multiplying have more ciphers in it, then there are places of decimals in the decimal fraction

fraction or mixt number given to be multiplied, then supply the vacant places with ciphers, as if ,4 is to be multiplied by 1000 the product is 400,0 or 400. If by 100, it is 40,0 *&c.*

CHAP. XXV.

Division in Decimals.

Division whether in pure decimals, or in Integers and decimals, is the same in operation with division of whole numbers, only care must be had to give a true denomination to the first figure of the quotient according to this Rule.

The first figure of the quotient is of the same denomination with that figure of the dividend which stands (or is supposed to stand) over the unite place of the divisor.

It will happen sometimes that the unite place of the divisor will stand beyond all the significant figures of the dividend towards the right hand, or towards the left hand; in this case you must

must place ciphers on the right or left hand of the dividend, untill you come over the unit place of the divisor

Examples.

36.47 by ,000268 will stand thus 000036.47 and the denomination of the first figure of the quotient will be tenns of thousands.
0.000368

If 868.5 be to be divided be .9865 they must stand thus. 868.50 (and the denomination of the first figure of the quotient will be hundreds.
0.9865

If .368 by 5.4 they will stand thus. .3680 (and the denomination of the first figure of the quotient will be hundredth parts in the second place of decimals.
5.4

In division of whole numbers, the remainder is the numerator of a common fraction, and the divisor is the denominator, and this fraction is part of the quotient: now if instead of this common fraction you desire to have a decimal

decimal fraction of the same value, put ciphers to the remainder, and continue the division. *Example.*

If 64 *l.* be to be divided amongst 5 men, each (according to the common way of division) will get 12 *l.* $\frac{4}{5}$, and according to the decimal way, each will get 12*l.* 8.

Common way	decimal way.
5 (4	5
64 (12 *l.* $\frac{4}{5}$	64. 800 (12*l.*8
55	555

If a decimal fraction, or a mixt number is to be divided by a decimal number, remove the separating line so many places towards the left hand, as there are ciphers in the decimal number; supplying the vacant places (if need be) with ciphers.

As if .45 is to be divided by 10, the quotient is, .045, if by 1000 the quotient is .00045, *&c.*

If 32.56 by 10 the quotient is 3.256. by 1000 the quotient is .32560, *&c.*

CHAP.

CHAP. XXVI.

Reduction of Common fractions into Decimal Fractions.

DIvide the numerator of the Common fraction, by the denominator, and the quotient is the Numerator of the decimal fraction.

Example.

As $\frac{1}{5}$ being reduced into a decimal fraction is .6.

3.000 (.6
5

Some Common fractions can never be exactly reduc'd into decimal fractions, without some remainder, when you meet with any such, after you have found 3 or 4 places of decimals, you may cease: As $\frac{1}{3}$ being reduc'd into a decimal fraction is .3333, and there will always remain 3.

3 (.3333 &c.
3.000
999

An

Any number of shillings, pence, Ounces, *&c.* are reduced into decimal fractions of their Integers, by dividing the number of shillings, *&c.* given, by the number of shillings, or, *&c.* contain'd in their whole.

Thus divide the number of shillings by 20.

The number of pence by 240.

The number of Ounces by 16 or 12.

The number of hours by 24. *&c.*

The quotients give the decimal fractions of pounds or days equal to them.

Example, decimals of a *l. day, hour, &c.*

15 *s* equal to ——— .75
16 *s* 8 *d* equal to ——— .833, *&c.*
3 Ounces at 12 in the *l.* equal to — .25
9 Ounces at 16 in the *l.* equal to .5625
19 hours equal to ——— .7916, *&c.*
35 Minites equal to ——— .583, *&c.*

CHAP.

CHAP. XXVII.

Reduction of Decimal Fractions into Common Fractions.

AS Common fractions are reduc'd into decimals by division, so decimal fractions are reduc'd into common fractions by Multiplication, for if you multiply the decimal by the given denominator of the common fraction, the product will be the numerator to that denominator of the Common fraction: As 75 being reduc'd into a common fraction whose denominator is 20; will be $\frac{15}{20}$ that is 15s

$$\begin{array}{r} .75 \\ \underline{20} \\ 15.00 \end{array}$$

Thus by multiplication you may express the value of any decimal fraction in the known parts of the Integar, *viz.* multiply the decimal given, by the number of known parts that the Integer contains, and the product gives the value sought: *Example*, the value of .25 of a *lb.* where 12 ounces make a *lb.* will be found to be 3 ounces.

Thus

Thus the value of ·864 will be found to be, 17*s*. 3*d*. 1*f*. *&c*. here what is loſt in the remainder is not one hundredth part of a farthing.

20
s. 17.280
12
560
280
d. 3.360
4
f. 1.440

So the value of this decimal of a day will be found to be 23 hours, 45 minutes 9 ſeconds *&c*.

989
24
3956
1978
hours 23.736
minits 45.160
60
ſecond 9 660

And thus you may value any decimal whatſoever in the known parts of the Integer.

CHAP. XXVIII.

CHAP. XXVIII.

Of ſimple Intereſt.

QUeſtions in ſimple Intereſt may be reſolved by the ſingle or double Rule of 3.

1. The ſimple intereſt of any principal for any time being known, the ſimple intereſt of any other principal (at the ſame rate of intereſt) for the ſame time may be found by the ſingle Rule of three as in theſe Examples following.

If 100*l.* in one year gain 6*l.* what will 360*l.* gain in the ſame time?

If 100*l.* —— 6*l.* —— 360*l.*

6

l. 21|60

20

s. 12|00

Cut off the two figures next the right hand from the product, the reſt are pounds, then multiply the figures cut off by 20 and 12, *&c.* (according to the Rule in the 27th Chap.) and you

you have the ſhillings and pence, &c.

What is the Intereſt of 400*l.*-12*s*-9*d* for 1 year at 6*l. per Cent. per annum?*

If 100*l.*——6*l.*——400*l.*——12*s*——9*d*

6

l. 24 | 03 —— 16 —— 6

20

s 0.76

12

d 9 | 8

Multiply by 6. as is taught in the 11th *Rule of Practice, pag.* 83. and then cut off, as is taught in this Chap.

2. The ſimple Intereſt of any principal, for any time being known, the ſimple Intereſt of any other principal (at the ſame rate of Intereſt for any other time may be found by the *Double Rule of* 3, as in the Examples following.

If 100*l.* in 3 years gain 18*l.* what will 340*l.* gain in 5 years?

If

If 100*l.* —— 18*l.* —— 340*l.*

years 3	5 *years*
300 *divisor*	1700
here work according to the directions in Chap. 15th pag. 87.	18
	13600
	1700
	30600 dividend

306 | 00 (102 *l.*
3 3 | 00

What is the Interest of 500*l.* for a week or 7 days at 6*l.* *p cent. per annum*?

If 100*l.* —— 6*l.* —— 500*l.*

365 *days*	7 *days.*
36500 *divisor*	3500
	6
	21000 *devid.*

$\frac{213}{365}$ | $\frac{33}{00}$ quotient $\frac{42}{73}$

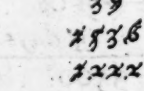
which being reduced is 11*s.* 6*d.* hence one vulgar errour is discovered, *viz.* some compute thus: 6*l.* for a year is 10*s.* for a moneth and 2*s.* 6*d.* for a week, wherefore according to that Computation the Interest of 500*l.* for a week would have been 12*s.* 6*d.* but it is truly but 11*s.* 6*d.* and some part

of a farthing, this mistake hath its rise, from the mistaking 28 days for the $\frac{1}{12}$ of a year or 365 when truely the $\frac{1}{12}$ of 365 is 30. $\frac{5}{12}$ days.

What is the simple Interest of 400*l.* for 5 years and 4 moneths at 6*l. p. cent. p. annum*?

If 100*l.*——6*l.*——400*l.*

12	64 *moneths.*
1200	25600
	6
	153600



By the help of this decimal fraction of a pound .00016438 3 which is very near the Interest of 1*l.* for a day at 6*l. p. cent. p. annum.* the Interest of any number of pounds for any number of days at the said rate of Interest may be found by multiplication only *viz.* Multiply the said decimal by the principal whose Interest is required, then multiply that product by the number of days given, so shall this last product be

be the Interest required: here in Multiplying, you must observe the Rules of decimal multiplication delivered in the 24th Chapter.

Examples.

What is the Interest of 1000*l.* for 15 days at 6*l. p. cent. p. annum* ?

	c00164383
facit 2*l.*	1000
9*s.* 3*d.*	000.164383
3*f.*	15
	821915
	164383
	l. 2.465745

CHAP. XXIX.

Of Compound Interest.

WHen it is required to know into what sum of money, any propounded principal, forborn any number of years will at the end of such term be augmented unto, Interest upon Interest being computed, at a given

given rate, there must be found a rank of continual proportionals, more in number by one, then is the number of years in the question; of which proportionals the first is the principal assign'd, the second must encrease or proceed from the first, the third from the second, *&c.* in such manner or rate as 106 proceeds from 100 (if the rate of Interest be 6 *p. cent.*) the last proportional answers the question. *Example*, What is the amount of 200*l.* being forborn 4 years at Interest upon Interest at 6*l. per Cent. per Annum*? say by the Rule of 3.

1. If 100——106——200 *facit* 212*l.* due at the end of the first year.

2. If 100—106—212 *facit* 224.72 due at the end of the second year.

3. If 100——106——224.72 *facit* 238.2032 at the 3*d.* years end.

4. If 100——106——238.2032 *facit* 252.495392, and so much will the 200*l.* principal be augmented to at the 4th years end, which is the number sought.

Note, The number first assigned, *viz.* 300*l.* and the numbers successively resulting

sulting at the ends of the several years are continual proportionals, which you may discover thus; continual proportionals have this peculiar property, that if any one of them which is plac'd between two, (one on each side) be multiplied by its self, the product is equal to the product of those two extreams.

Note, That if to two given numbers there be required a 3*d* or 4th, *&c.* in continual proportion, multiply the proportional by its self, and divide the product by the first proportional, the quotient gives a third proportional: Again, Multiply the 3*d* by its self, and divide the product by the second, the quotient gives a 4th proportional, and so a fifth and a sixth may be found in continual proportion.

According to this Rule is the following table calculated.

A Table shewing the Amount of 1l. being forborn any number of years under 31 compound Interest being computed at 6 p. Cent. p. Annum.

years	decimals of a pound	years	decimals of a pound.
1	1.06000	16	2.54035
2	1.12360	17	2.69277
3	1.19101	18	2.85433
4	1.26247	19	3.02559
5	1.33822	20	3.20713
6	1.41851	21	3.39256
7	1.50363	22	3.60353
8	1.59384	23	3.81975
9	1.68947	24	4.04893
10	1.79084	25	4.29187
11	1.89829	26	4.54938
12	2.01219	27	4.82234
13	2.13292	28	5.11168
14	2.26090	29	5.41836
15	2.39655	30	5.74349

The use whereof will appear in the following Examples.

The

What will 130*l.* be augmented unto, being forborn 5 years, Interest upon Interest being computed at 6*l. p. cent. p. annum.* first see in the table, what 1*l.* will amount unto in that time and you will find it to amount to 1*l.* 33822, then say,

If 1*l.* —— 1*l.* 33822 —— 130*l.*

130

40146 60

133822

173.9680

facit 163*l.* 19*s.* 4*d.* 1*f.*

What will 200*l.* amount to being forborn 15 years Interest upon Interest at 6*l. p. cent. p. annum.*

You may see in the table, that 1*l.* in that time will amount to 2.39655. therefore say,

If 1*l.* —— 2*l.* 39655 —— 200

200

479.31

facit 479*l.* 31 or 6*s.* 2*d.* 1*f.*

CHAP. XXX

Of Rebate or Discount.

REbate or discount of money is, when a sum of money due at any time to come, is satisfyed by the payment of so much ready money, which if it were put to use for that time would amount to the sum due.

Thus if 25*l.* be due at the end of 2 years, and is to be satisfied by the payment of present money upon rebate after the rate of 6*l. per Cent. per annum*, there ought to be so much ready money paid, which in that time at the said rate of Interest would be augmented to 25*l.*

1. Of Rebating at simple Interest.

A Merchant sells goods to another to the value of 250 *l.* to be paid at 9 moneths end, but it is convenient to both of them, that the money be presently paid upon Rebate at 6*l. per cent. per annum* simple Interest: I demand, how much ready money ought to be paid for the goods?

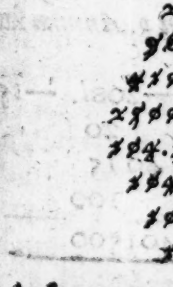
First,

First, finde the Interest of 100*l.* for that time, *viz.* 9 moneths, which is 4*l.*5 then add that Interest to 100*l.* and make the sum the first number in the Rule of 3. make 100*l.* the second, and the sum to be rebated the third, the 4th gives the number sought, thus,

104*l.*5 — 100*l.* — 250*l.*

100

25000



Answer 239*l.*23 ought to be paid ready money.

What is the Rebate of 320*l.* for 15 moneths, at 8*l.* *p. Cent. p. Annum* simple Interest?

If 110 —— 100 —— 320*l.*

32000

290*l.* $\frac{10}{11}$

was to be paid 320

ought to be paid 290 $\frac{10}{11}$

Rebate —— 29 $\frac{1}{11}$

What is the Rebate of 200*l.* 15*s.* for 16 moneths at 9*l.* p. *Cent* p. *Annum* simple Interest?

If 112 —— 100 —— 200*l.* —— 15*s.*

20

40 15

100

401500

358 $\frac{22}{112}$

179*l.* 4*s.*

at first due 200*l.* —— 15*s.*

to be paid 179 —— 4 $\frac{22}{112}$

Rebate. 21 —— 10 $\frac{10}{112}$

2. Of Rebate at compound Interest.

A debt of 252*l.* 495392 is due at the end of 4 years, the question is, how much

much present money will satisfy that debt upon rebate of *Interest* upon Interest at 6*l. p. Cent. p. Annum*?

The work of such like questions will not be much different from that in the 29th Chapter, *viz.* there must be be found a rank of Continual proportionals more in number by one, than is the number of years in the question; of which proportionals the first must be, the debt of money to be rebated, the second must decrease or lessen from the first, the third from the second, the 4th from the 3d, *&c.* In such manner as 100 decreaseth from 106 (if the rate of *Interest* be 6 *p. Cent.*) then will the last proportional be the answer of the question: see the work of the Example.

1. If 106—100—252.495392 *facit* 238.2032
2. If 106—100—238.2032 *facit* 224.72
3. If 106—100—224.72 *facit* 212
4. If 106—100—212 *facit* 200*l.*

so much ready money will satisfy the debt; upon this ground is the following Table calculated.

A3

A Table shewing the worth of 1l. due at any term of years to come under 31, in ready money, rebate being made at 6 p. Cent. p. Annum Compound Interest.

years	decimals of a pound	years	decimals of a pound
1	.943396	16	.393646
2	.889996	17	.371364
3	.839619	18	.350343
4	.792093	19	.330512
5	.747258	20	.311804
6	.704960	21	.294155
7	.665057	22	.277505
8	.627212	23	.261797
9	.591898	24	.246978
10	.558391	25	.232998
11	.526787	26	.219810
12	.496289	27	.207367
13	.468839	28	.195630
14	.442300	29	.184556
15	.417265	30	.174110

The

The use whereof will appear in the following Examples.

How much will discharge a debt of 300*l.* payable at the end of 9 years to come by rebating at 6 *p. cent. p. annum.* compound interest?

Look against 9 in your table and you'l will find .591898, which is the present worth of 1*l.* due at that time, rebate made as before, then say,

If 1*l.* —— .591898 —— 300*l.*

300

177.5694

facit 177*l.* 11*s.* 4*d.* 2*f.*

The proof of Rebate,

when you have found the sum of present money that will satisfy the debt, then if the rebate be at simple *Interest*, for proof of your work, see what that sum would amount to at the same rate of simple *Interest*, but if the rebate be at compound *Interest*, see to what the sum found would amount at the same rate of compound *Interest*, and if the amount of the ready money be equal to the debt, your work is true, if unequal the work is false.

Thus

Thus if 200*l.* were put to use, at the rate of 6 *p cent.* Compound *Interest*, it would amount to 252*l.*495392. the debt which it discharges in ready money.

CHAP. XXXI.

Of Annuities.

QUestions concerning Annuities may be comprehended under these 4 heads, *viz.*

1. To finde the Amount or worth of an Annuity payable yearly, that is in arrear for any number of years, at any rate of simple *Interest*.

Example,

If an Annuity or yearly Rent of 100*l.* be forborn till the end of 4 years, the question is, what will it amount to at the end of the 4 years simple *Interest* of 6 *p. Cent*: *p. Annum* being computed for each years rent, from the time on which it was due, to the end of the said term of 4 years?

First consider, that according to the question there must be computed the interest

Intereſt of 120*l*. due at the firſt years end for 3 years (*viz.* ſecond, third and fourth years), alſo the intereſt of 100*l*. due at the ſecond years end for 2 years, and laſtly the intereſt of the like ſum due at the third years end for 1 year, all which intereſt add to the ſum of the 4 years rent, the totall ſum will give the amount of the Annuity at the end of the ſaid term of 4 years.

See the work

The intereſt of 100*l*. at 6 *p. Cent. p. Annum*	*years l.*
ſimple intereſt for	3 is 18
The intereſt of 100*l*. for	2 is 12
for 1 year	1 is 6
the ſum of the 4 years rent is	400
total amonnt of the Annuity.	436

2. Suppoſe an Annuity of 150*l*. be forborn till the end of 7 years, what will it amount to at the end of the ſaid term of 7 years, ſimple intereſt, being computed at 6 *p. Cent. p. Annum.* for each years rent, from the time it becomes due, to the end of the 7 years.

Firſt

	years	l.	s.	d.
First, the interest of 150l. the first years rent for	6	—	1s	— 54
the interest of the like sum for	5	—	1s	— 45
for	4	—	1s	— 36
for	3	—	1s	— 27
for	2	—	1s	— 18
for	1	—	1s	— 09
the sum of the 7 years rent is				1050
total Amount of the Annuity.				1229

2. To find what an Annuity payable yearly will amount to being forborn any number of years, and a certain rate of compounded interest for each yearly payment being computed from the time it became due, to the end of the term of years.

Example.

1. Suppose an Annuity of 200l payable yearly, be forborn till the end of 4 years, what will it then amount to, interest upon interest of 6 *p. Cent. p. Annum.* being computed for each years payment from the time it became due

due to the end of the said term of 4 years? Here its evident, that there must be computed the compound interest of 200*l.* due at the first years end for 3 years. Also the compound interest of the like sum due at the second years end for 2 years, and the interest of the like sum due at the third years end for 1 year. All which Interests being added to the 4 yearly rents make the total amount of the Annuity.

	years		*l*
Thus the interest	3		38.2032
of 200*l.* for	2	is	24.72
	1		12

the sum of the 4 yearly payments ——— 800

total amount of the Annuity. 874.9232

2. What will be the amount of an Annuity of 300*l.* payable yearly, if forborn till the end of 4 years, interest upon interest being computed, for each yearly payment, from the time it becomes due, to the end of the 4 years.

Here is first the compound interest of 300*l.* due at the first years end for 3 years ——— 57*l.*3048

the

the compound intereſt of
the like ſum for 2 years—37.28
alſo for 1 year———18
the 4 yearly payments—1200

total Amount of 1312.3848
the Annuity.

Note, If an Annuity payable at yearly payments, be improved at compound intereſt, and all forborn unto the end of certain years, the total then due will be the ſum of a rank of continual proportionals, as many in number, as there are yearly payments, the firſt of which proportionals is the firſt years payment, and the ſecond proceeds from the firſt, in the ſame rate as 106 from 100 (if it be at 6 *p. Cent.*) and ſo the third from the ſecond *&c.* after the manner in the 29th Chapter.

A Table shewing what 1 pound Annuity payable by yearly payments, and forborn any number of years under 31 will amount unto, at the end of the term, compound Interest being computed at 6 p cen. p. Annum.

years	*decimals of a pound*	*years*	*decimals of a pound*
1	1.00000	16	25.67252
2	2.06000	17	28.21287
3	3.18360	18	30.90565
4	4.37461	19	33.75999
5	5.63709	20	36.78559
6	6.97531	21	39.99272
7	8.39383	22	43.39228
8	9.89746	23	46.99582
9	11.49131	24	50.81557
10	1 .18079	25	54.86451
11	14.97163	26	59.15638
12	16.86994	27	63.70576
13	18.88213	28	68.52810
14	21.01506	29	78.63979
15	23.27596	30	79.05818

The

The uſe of the table will appear in the reſolving this queſtion, what will be the Amount of an Annuity of 10 *l.* payable yearly, and forborn 9 years, compound Intereſt being Computed at 6 *per Cent.* for each yearly payment from the time it becomes due to the end of the 9 years? look againſt 9 in the table, and you will finde this number 11*l.*49131 which is the Amount of 1*l.* Annuity payable yearly and forborn 9 years at Compound Intereſt; ſay then, If 1*l.* give 11*l.* 49131 what 10*l.* *facit* 114*l.*9131.

3. To finde the preſent worth of Annuity to continue any number of years by rebating or diſcompting at ſimple Intereſt.

1. There is Annuity of 50*l.* to continue 5 years, what is it worth in preſent money, rebate being made at ſimple Intereſt 6 *per Cent. per Annum?*

Here you muſt firſt compute the preſent worth of 50 *l.* due at the firſt years end, alſo the preſent worth of 50*l.* due at the ſecond years end, and ſo for the third, 4th and 5th, all which preſent worths being added together, give

give the present worth of the Annuity.

The present worths of each particular sum due at each years end may be found, as is taught in the 30th Chap. thus.

1. *If* 106*l.*—100*l.*—50*l.* due at the first years end *facit* 47.169 x.

2. *If* 112—100—50 due at the second years end *facit* 44*l.* 042 x

3. *If* 118—100—50 due at the third years years end *facit* 42*l.*373 x

4. *If* 124—100—50 due at the fourth years end, *facit* 40.322 x

5. *If* 130—100—50 due at the 5th years end *facit* 38. 461 x

sum of all the present worths is 212*l.*967 x

The present worth of an Annuity of 50*l.* to continue 5 years, rebate made at 6 *per Cent.* simple *Interest.*

2. There is an Annuity of 80*l.* to continue 4 years, what is its present worth, rebating at 6 *per Cent.* simple *Interest?*

Finde the present worth of each sum when it becomes due, thus.

If

If 106——100——80 *facit* 76*l.*415
If 112——100——80——71.428
If 118——100——80——67.796
If 124——100——80——64.516

the sum is the present——280.155
work of the Annuity.

4. To finde the present worth of an Annuity that is to continue any certain time, by rebating at any rate of compound *Interest*.

There is an Annuity of 60 *l. per annum*, to continue 3 years, what is the present worth of it, rebating at 6 *per Cent.* Compound *Interest*?

It is evident by the question, that we must finde the present worth of 60*l.* due at the first years end, and the worth of the like sum due at the second years end, as also the present worth of the like sum due at the third years end, rebating at 6 *per cent.* Compounded *Interest*, all which present worths being found, as is taught in the 30th *Chapter*, and added together, do give the present worth of the Annuity, thus the present worth of 60 *l.* payable at the first years end will be

be found to be——————56*l.* 6037 x
Alſo the preſent worth of 60*l.* payable at the ſecond years end--53. 3997 x
At the third years end——48.9778 x
Sum of all is the preſent worth of the Annuity. 158.9812

2. There is an annuity payable yearly of 100*l.* to continue 50 years what is it worth in preſent money rebating at 6 *per cent* : compound *Intereſt*?

The preſent worth of 100*l.* due at the firſt years end————is 94*l.* 3396 x
Due at the 2d years end is 88. 9996
At the 3d years end——is--83. 9619
At the 4th years end——is--79. 2093
At the 5th years end——is--74. 7258
Sum of all is the preſent worth of the Annuity. 421.2362

The

A Table shewing the present worth of 1 l. Annuity payable by yearly payments, and to continue any term of years under 31 compound Interest being computed at 6 l. per cent : per Annum.

years	decimals of a pound	years	decimals of a pound
1	.94339	16	10.10589
2	1. 83339	17	10.47725
3	2. 67301	18	10.82760
4	3. 46510	19	11.15811
5	4. 21236	20	11.46992
6	4. 91732	21	11.76407
7	5. 58232	22	12.04185
8	6. 20979	23	12.30337
9	6. 80169	24	12.55035
10	7. 26008	25	12.78335
11	7. 88687	26	13.60316
12	8. 38384	27	13.21053
13	8. 85268	28	13.40616
14	9. 29498	29	13.59071
15	9. 71229	30	13.76482

The

The use of this table will appear in the following *Example.*

An Annuity of 300*l.* payable yearly and to continue 7 years, what is it worth in ready money, rebating at 6*per cent.* Compound *Interest*? look in the table in the Column against 7, and you will finde this number 5.58233, which is the present worth of 1*l.* annuity to continue 7 years; rebating at 6 *per cent. per annum* compound *Interest*: say then,

If 1*l.* —— 5.58233 what 300? *facit* 1674*l.* 699 the present worth of the Annuity of 300*l.*

For proof of your work, in finding the present worth of an Annuity, observe, that there must be no more money paid for the purchase of an Annuity, then being put to use, according to the same rate of *Interest*, whether simple or compound, would amount to as much as the particular payment of the Annuity would amount being improved at the same rate of Interest: and this may serve for a sure proof, it being the foundation of finding the present worths of Annuities.

A brief way for finding the amount of an Annuity payable yearly, computing at any rate of compound Interest and forborn for any number of years.

Finde a principal that may have such proportion to the Annuity as 100 hath to 6 (if the Interest be at 6 *per cen.. per annum.*) then see what that principal would amount to, if forborn for the same term of years that the Annuity is to continue, then from that amount substract the principal first found, the Remainder gives the amount of the Annuity at the end of the term of years mentioned in the question.

Example.

An Annuity of 300*l.* to continue 4 years, what will it amount to computing Interest upon Interest of 6 *p. cent. p. ann.* for each yearly payment from the time it becomes due to the end of the term of 4 years; first say by the Rule of 3,

If 100. *et* 300 *facit* 5000 for a principal, then see what 5000*l.* forborn 4 years

4 years will amount to at *6 per cent.* compound interest, you will finde it by the Rules in the 29 Chap. to amount to 6312.3848 from which subtract the said principal 5000 the Remainder is 1312.3848 being the amount of an Annuity of 300*l.* to continue 4 years at *6 per cent.* compound Interest.

The Reason of this Rule.

The Amount of a principal put forth at Interest upon Interest payable by yearly payments and all forborn till the end of certain years, is equal to these 3 numbers, *viz.*

1. The principal it self that was put forth.

2. The sum of the simple interest due at each years end.

3. The utmost improvement of these Annual simple Interests by computing interest upon interest.

If then from the said amount or aggregate, we subtract the principal, there will remain the annual simple interests (which are in the nature of an annuity; and the utmosts improvements of them, by computing compound interest or the utmost improve-

ment of the payments of the annuity.

A compendious way of finding the present worth of an Annuity payable yearly that is to continue any number of years, rebating at any rate of compound interest.

Finde a principal that may have such proportion to the Annuity as 100 has to 6, then supposing this principal a sum due, at the end of the time mentioned in the question, find its present worth at the same rate of compound interest according to the Rules in the 30th Chap. which present worth substracted from the principal first found, leaves the present value of the Annuity in ready money.

Example.

An Annuity of 300*l*. to continue 3 years compound interest to be computed, what is it worth in present money rebating at 6 *per cent.* compound interest? say,

If 6 — 100 — 300 *facit* 5000*l*. principal, then 5000*l*. to be payd at the end of 3 years to come is worth in ready money

money (by the Rule in the 30th Chap.) 4198.095 which ſubtracted from the principal 5000*l.* the Remainder 801*l.*905 is the preſent worth of the Annuiry.

The Reaſon of this Rule.

If the principal found *viz.* 5000*l.* be put forth as a principal at Intereſt upon Inteteſt, it will in 3 years time amount to a ſum which will be equal to theſe 3 numbers, *viz.* the principal it ſelf 5000*l.* the ſum of the annual ſimple Intereſts, and the utmoſt improvements of theſe annual ſimple intereſts at Compound Intereſt. Now becauſe 4198*l.*095 will in 3 years time amount to 5000*l.* therefore the remaining part of the 5000*l.* principal *viz.* 801*l.*905 will be equal to the remaining part of the Amount of 5000*l.* put forth at intereſt upon intereſt, but the remaining part of the amount is the annual ſimple intereſts (which is in the nature of an Annuity) and their utmoſt improvements (which are the improvements of the Annuity) that is, the remainder is the annuity of 300*l.* and its utmoſt im-

provement at 6 *p. Cent. per annum* compound intereſt.

5. To finde by the laſt table how many years purchaſe an Annuity or leaſe for years is worth.

To know how many years purchaſe an Annuity iſſuing out of Lands for 21 years to begin preſently is worth if it were to be ſold for ready money at 6 *per cent. per annum.*

Seek in the firſt Column of the table for 21 years, and the number anſwering to it is 11.76407 which ſhows that the annuity is worth 11 years purchaſe and $\frac{1}{4}$ x.

6. To finde what Annuity (to continue any number of years, and according to any given rate) any ſum of money propounded will purchaſe.

Firſt, ſuppoſe any annuity at pleaſure to continue for the term of years propounded; then finde the preſent worth of that annuity in ready money (as is taught in this Chapt.) at the Rate of intereſt aſſigned; then ſay,

As the value found is to the ſuppoſed annuity, ſo is the ſum of money propounded to the Annuity required.

What

What Annuity to begin presently and to continue 3 years will 800*l.* purchase at 6 *per cent.* compound interest?

Now suppose an Annuity of 300*l.* payable yearly for 3 years, then the value thereof is (as we found in this Chap.) 801*l.*905 therefore say by the Rule of 3,

As 801.905 is to 300 so is 800*l.* to 299*l.* 28 x.

What Annuity payable by yearly payments to continue 37 years will one pound purchase at 6 *per cent. per annum*, interest upon interest?

First, finde out the present worth of 1*l.* annuity to continue 37 years which (by the Rules already delivered) you will finde to be 14*l.*73678, then say,

If 14*l.*73678——will purchase an annuity of 1*l.* to continue 37 years, what will one pound purchase to continue the same term? *facit* 06785 or 1*s.* 4*d.*

CHAP. XXXII.

Of Equation.

THe Rule of Equation of payments teacheth to reduce ſeveral days of payment upon which particular ſums of money are due, unto a mean time, upon which the Aggregate or total of thoſe particular ſums ought to be paid, without damage to the debitor or Creditor.

Example.

A Merchant oweth 900*l.* to be paid at 3 payments, *viz.* 200*l.* at 1 years end, 300*l.* at 3 years end, and 400*l.* at 4 years end, and agrees with his creditor to pay the whole debt at one payment; the queſtion is, when ought the payment to be made without damage to the debitor or creditor, rebating at 6 *per Cent. per Annum* Intereſt?

The Rule is,

Finde the preſent worth of each particular payment by the directions in the 30th Chap. then finde in what time the ſum of thoſe preſent worths will be

be augmented into the total of all the particular sums payable at times to come, according to the agreement, so shall the time found be the mean or equated time for the payment of the whole debt; thus in the last Example.

The present worth of 200*l.* payable at one years end is,——— 188*l.*678

The present worth of 300 *l.* payable at the end of 3 years is,——— 254.237

The present worth of 400*l.* payable at 4 years end is,——— 322.58

Sum of the present worths-765.495

which substracted from 900 leaves 134*l.*505. Then say by the double Rule of 3.

If 100*l.* in 12 mon. gain 6*l.* in what time will 765*l.*495 gain 134.505--*facit* 35 *mon.* 1282 x which is the time sought; for if at 35 moneths end 900*l.* be paid, it will satisfie the three payments of 900*l.* as in the example; which you may prove thus.

The proof.

Finde what Is the prefent worth of 900 *l.* due at the end of 35 moneths 1282 as is taught in the 30 Chapter, which you will finde to be the ſame with the preſent worths of the payments in the queſtion, therefore the work is true.

Here by the way, *I* will demonſtrate the Rule of Equation of payments to be falſe which is delivered by ſeveral Arithmetical writers, & by them much inſiſted on.

In order thereunto *I* will work the laſt example, according to that Rule, which is this,

Multiply each particular payment by its time, then add all the products together and divide the total by the whole debt

then 200 by 1 year is——200
And 300 by 3 years——900
laſtly, 400 by 4 years—1600
ſum 2700

which divided by the whole debt, *viz.* 900 *l.* the quotient is 3 which is the equated time, which whether it be true

or

or not, I thus examine, the present worth of the debt to be paid, as in the question is found (by the Rules already delivered) to be 765*l*.495 but the present worth of 900*l*. due at the end of 3 years is 762.72 which is lesse then the present worth of the debt being paid, as in the question by 2.772 and so much the Creditor loses by receiving the money so much longer then he ought, wherefore that Rule (and all others depending thereon) is false.

A debtor is to pay 400*l*. at three payments, *viz*. 200*l*. at 6 moneths end 50*l*. at 9. moneths end, and 150*l*. at 15 moneths end, but he agrees with his creditor to pay the whole 400*l*. together, the question is, when ought that payment to be made without loss to either debtor or creditor, at 8. *per cent*. Interest?

The

The preſent worth of 200*l.* *l.*
due after 6. mon. is——192.307
Of 50*l.* due after 9. mon.——47.169
Of 150*l.* due after 15 mon.—136.363
Sum of the preſent worths—375.839
ſubſtracted from 400 leaves for a remainder——24*l.*161

Then ſay,

If 100*l.* in 12. moneths gain 8*l.* when will 375*l.*839 gain 24*l.*161 *facit* 9 mon. 56799 x the mean time: for the preſent worth of 400*l.* due at the end of 9. mon. 56799 x is 375.839 very near.

The directions given are ſo plain, that I need not multiply examples.

CHAP. XXXIII.

Of Loſs and Gain.

QUeſtions concerning Loſs and Gain may be comprehended under theſe 4 heads, *viz.*

1. To know what is gaind or loſt *per Cent.*

If

If an ell of Linnen Cloth cost 11*s.* and is sold for 9*s.* 6*d*, how much is lost, *per cent*?

Substract 9*s.* 6*d.* from 11*s*, the remainder is 1*s.* 6*d.* the loss upon each ell, then say,

If upon every 11*s.* there be 1*s.* 6*d.* lost, how much loss is upon every 100*l.* the 4th number found by the Rule of 3 is 13*l.*——12*s.* $\frac{7}{10}$ x the loss.

If 1*l.* of tobacco cost 17*d* and be sold for 21*d*, what is gain'd *per Cent*?

21

Substract—— 17

4

If 17*d* gain 4*d.* what 100*l*? *facit* 23*l.* 0*s.* 7*d.* $\frac{1}{7}$ gain.

2. To know what a Commodity ought to be sold for to gain or lose so much *per Cent.*

If 100*l.* of any Commodity cost 30*s*, how must 1*l.* of that Commodity be sold to gain 10*l. per cent*?

Make 100*l.* the first number in the Rule of 3, the price the second, and 100*l.* with the gain added to it, or the loss substracted from it the third, the 4th gives the price the whole commo-

dity

dity ought to be sold for: according to which, you may by the Rule of 3 finde the price of any part of the Commodity: thus in the Example.

If 100*l.*—330*s.*—110*l.* *facit* 33*s.* the whole Commodity ought to be sold for, then,

If 100*l.*—33*s.*—1*l.* *facit* $\frac{33}{100}$*s.* or 3$\frac{24}{25}$*d.* the price of 1*l.* of that Commodity, according to 10*l.* *per Cent.* gain.

If 60 *yds* of holland cost 18*l*, for how much must the yard be sold to loss 8*l.* *p. Cent*?

As 100*l.*—18*l.*—92*l.* *facit* 16*l.*56 the price of the holland at the Rate of 8 *per Cent.* loss, then,

If 60 *yds.*—16*l.*56—1 *yd facit* $\frac{276}{1000}$ the price of one yard

3. Having gained or lost so much *per cen.* to know what the commodity cost.

If a parcel of Jewels be sold for 560*l.* and there be 12*l.* loss *per Cent.* to know what they cost?

Substract the loss from 100*l.* and make the remainder the first number in the Rule of 3 100*l.* the second, and the price given the third, the 4th number gives the first price sought thus,

If 88*l*.--100*l*.--560*l*. *facit* 636*l*.636x. what the Jewels cost at first.

If 40 *yds* of Cloth were sold for 56*l*. at 9*l*. *per Cent*. gain, what did 1 *yd* cost?

If 109*l*.—100*l*.—56*l*. *facit* 51*l*.376 the price of the 40 *yds*.

Again, *If* 40 *yds*—51*l*.376—1 *yd facit* 1*l*.2844 the price of 1 yard.

4. *If* a Commodity sold at a given rate, do gain, or lose a given rate *per Cent*. to know what would be gain'd or lost *per Cent*. if the commodity were sold at another rate?

If 1*l*. of tobacco be sold for 22*d*, and there be gain'd 12 *per Cent*. how much *per Cent*. will be gain'd or lost if 1*l*. of tobacco be sold for 18*d*?

Let the first price be the first number in the Rule of 3, 100*l*. with the gain added, or the loss substracted the second number, and the other price the third number, Example,

If 22*d*.—112*l*. gain—18*d*. *facit* 8*l*. $\frac{4}{11}$ loss *per Cent*.

If one Gallon of wine be sold for 8*s*, at 8 *per Cent*. loss; how much will be gain'd or lost *per Cent*. if the Gallon of wine be sold for 12*s*?

If

If 8*s.*—92—*loss*—12*s.*—*facit* 38*l. per cent.* gain.

CHAP. XXXIV.

Of Arithmitical Progression.

A Rank of numbers orderly encreasing or decreasing by equal differences is called an Arithmetical progression, such are these two ranks,

2. 4. 6. 8. 10, *&c.* encreasing
10. 8. 6. 4. 2, decreasing.

Questions concerning Arithmetical progressions, that ordinarily occur may be comprehended under these heads, *viz.*

1. The least term of an Arithmetical progression, the common difference, and the number of terms being given to finde the sum of the progression.

Multiply the common difference by the number of the terms lesse by one, and add the product to the least term, the sum is the greatest term of the progression then multiply ½ the sum of the least and greatest terms, by the number

ber of terms, or multiply the sum of the greatest and least term into the ½ of the number of terms, either of the products give the sum of the progression, Example.

There were soldiers taken up for the space of 30 days, the first day there were 300 taken up, and every one of the other days there were so many taken up as the first day, and 10 more, the question is how many soldiers were taken up in all?

Here the difference is 10, the first term, 300, the number of terms 30, wherefore (by the Rule) 29 multiplied by 10, the product is 290, which added to the first term, the sum 590 is the last term, of the progression; which being found, multiply the sum of 590 and 300, *viz.* 890 by 15 (½ the number of term) the product 13350 is the sum of the progression, and so many soldiers were taken up in the 30 days time.

Another Example.

One had 20*l.* of tobacco worth 1. *s.* *per l.* which he sold for 1*d* the first pound, and augmented his price 3*d* more

more for every pound then was payed for the former, the queſtion is, what received he for his tobacco? and whether he gained or loſt?

Here the Number of terms is 20, the common difference 3, the firſt term 1. To finde the ſum of the terms, multiply 3 by 19, to the product add 1, the ſum is the greateſt term, *viz.* 58. then multiply the ſum of 58 and 1, *viz.* 59 by 10 ($\frac{1}{2}$ the number of terms) the product 590*d* or 2*l.* 8. *s.* 4*d* gives the ſum of the progreſſion, ſo that he gained by the ſale of the tobacco 1*l.* 8*s* 4*d.*

2. Having the firſt and laſt terms together with the ſum of the progreſſion to finde the number of terms.

Double the ſum of the progreſſion, and divide the ſum by the ſum of the firſt and laſt terms, the quotient gives the number of terms.

Example.

There was 685 *l.* disburſed in Arithmetical progreſſion to ſeveral perſons, the firſt perſon got 19*l.* and the laſt 118*l.* I demand how many perſons received of this money?

Here 685 ſum of the terms 19 the firſt

first and 118 the last term double of 685 is 1370 which divided by the sum of 19 and 118, *viz.* 137 the quotient is 10 and so many persons received of the money.

Another Example.

A workman received for several days work 1*l.*16*s* 8*d* being allowed for every days work according to Arithmetical progression, *viz.* for the first day 20*d*, for the last day 60*d*, the question is, how many days did he work?

Here 440*d* the sum of the terms 20 and 60 the first and last terms the double of 440 is 880 which divided by the sum of 20 and 60, *viz* 80, the quotient is 11, and so many days he wrought.

3. An Arithmetical progression being given, to continue the same through so many terms, until the sum of the progression be equal to the product of the Multiplication of a given number into the number of terms of the progression.

Double the least term then (if that double be greater than the common difference

difference of the progression) from that double subtract the common difference, the remainder subtract from the double of the given number, and that remainder divided by the common difference, the quotient gives the number of terms sought; but if the double of the least term be less than the common difference, then to that double of the given number add the difference between the double of the least term and the common difference, the sum divided by the common difference, the quotient gives the number of terms as before.

Examples.

1. Two persons together give to the poor an equal sum of money, one every day gives 10*s.* the other gives the first day 3*s.* and thereafter gives every day as much as he gave the day before, and 2*d.* more, *I* demand, how many days they gave to the poor, and how much?

Here the given number is 10, the difference 2, the first term 3: double the given number, *viz.* 10, and it is 20, then

then ſubſtract the difference 2, from 6, the double of the leaſt term, the remainder is 4; which (becauſe the double of the leaſt term is greater than the difference) ſubſtract from the 20 (the double of the given number) the remainder, *viz.* 16 being divided by the difference 2, the quotient 8 is the number ſought.

2. Two ſtudents travel from *Leyden* to *France*, *A* travels every day 6 miles, and *B* travels the firſt day 1 mile, the next 2 miles, the third day 3 miles, and ſo thereafter he travelled 1 mile more the following day, than he had travelled the preceding day, the queſtion is, in how many days will the two ſtudents meet?

Here the number given is 6, the firſt term 1, the difference 1 from 12 (the double of the given number) ſubſtract 1 (the difference between 1 the difference, and 2 the double of the leaſt term) the remainder is 11, which divided by 1 (the difference) the quotient is 11, wherefore in 11 days they will meet, which you may prove thus.

The

The proof.

Having the number of terms which is the number found, and the difference and the leaſt term, finde the ſum of the progreſſion by problem firſt, which if it be equal to the product of the given number multiplied into the number ſought, your work is true: thus the ſum of our progreſſion you will finde to be 66, which is the product of 6 multiplied into 11.

4. The leaſt term, and the number ofterms of a progreſſion given, which being multiplied into a given number the product is equal to the ſum of the progreſſion, to finde the progreſſion.

From the double of the given number, ſubſtract the double of the leaſt term, divide the remainder by the number of terms leſſe by one, the quotient gives the common difference of the terms of the progreſſion, by which according to the 1 head you may finde the numbers of the progreſſion.

Examples.

1. Two perſons in the ſpace of 4 days gave equal ſums of money to the poor, one gave every day 7*d*, the other gave the firſt day 1*d*, and thereafter he gave every day as much as he had given the day before, and a certain number of pence more, which was every day the ſame: the queſtion is, how much did he give every day, and how much was given in all?

Here the number of terms is 4, the number given 7, the firſt term of the progreſſion 1. from 14 (the double of the given number) ſubſtract 2 (the double of the leaſt term) the remainder is 12, which divide by 3 (one leſs than the number of terms) the quotient 4 gives the common difference, wherefore the terms of the progreſſion will be 1. 5. 9. 13 the ſum is 28 which becauſe it is equal to the product of 4 and 7 the work is true, for ſo many pence the firſt man gave, as the ſecond.

2. Two footmen meet at the end of 8 days, each having travelled an equal number of miles in this ſort, one travelled every day 16 miles, the other travelled

travelled the first day 2 miles, and thereafter every day so many as the day before, and a certain number of miles more always the same, the question is, how many miles did the second man travel every day? from 32 (the double of the given number) substract 4 (the double of the least term) the remainder is 28, which divided by 7 (one less than the number of terms) the quotient *viz.* 4 gives the common difference sought, by which the terms of the progression will be found to be 2. 6. 10. 14. 18. 22. 26. 30. the sum 128 equal to the product of 8 into 16.

There are many more questions concerning Arithmetical progressions which depend upon the resolution of other problems, but my design being only to lay down such Rules as may resolve the more familiar questions, I shall pass by the other questions, and refer the Reader to the 20 problems invented by Mr. *Oughtred*, and set down in the 19th Chap. 6. problem of his *Clavis Mathematica*.

CHAP.

CHAP. XXXV.

Of Geometrical Progreſſion.

GEometrical Progreſſion is a *ſeries* or rank of numbers encreaſing or decreaſing by equal proportion, ſuch are theſe.

encreaſing in a double proportion,

2. 4. 8. 16. 32. 64.

decreaſing in a double proportion,

96. 48. 24. 12. 6. 3

here the quotients of each following term divided by the former are equal.

In Geometrical proportionals the firſt and laſt are called Extremes, and the reſt means.

Some Queſtions concerning Geometrical progreſſions may be reduced to theſe heads, *viz.*

1. The firſt and laſt terms together with the rate or proportion being given to finde the ſum: Note; the rate is found by dividing one term by another, for the quotient gives the rate.

Multiply the laſt term by the rate found, from the product ſubſtract the firſt term, divide the remainder by a number leſſe by than the Rate, the

quotient gives the ſum of the progreſſion. **Example.**

The laſt term of a progreſſion is 384 the firſt term 3 the rate 2 to finde the ſum.

Multiply 384 (the laſt term) by 2 (the rate) the product is 768 from which ſubſtract 3 (the firſt term) the remainder is 765 which divide by 1 (a number leſs by 1 than the rate) the quotient is 765, the ſum of the progreſſion ſought. Or thus,

From the greateſt term ſubſtract the leaſt term, divide the remainder by the rate leſs by one, the quotient added to the greateſt terms gives the ſum of the progreſſion; thus in the laſt Example, 3 from 384, the remainder is 381, which divided by 1 is 381, to which if you add 384, the ſum is 765, the ſum found as before.

2. The Rate, greateſt term, and ſum of a Geometrical progreſſion being given to finde the leaſt term; multiply the rate leſs by 1 into the ſum given leſs by the greateſt term, ſubſtract the product from the greateſt, the remainder gives the leaſt term. *Example.*

The

The rate is 2 the ſum 765 and the greateſt term 384 to find the leaſt term.

Multiply 765 leſs by 384 (that is 381) by 2 leſs by 1 (that is 1) the product *viz.* 381 ſubtracted from the greateſt term, *viz.* 384 leaves 3 the term ſought.

3. The ſum rate and leaſt term being given to finde the greateſt term.

Multiply the rate leſs by 1 into the ſum given, to the product add the leaſt term, that ſum divided by the rate, the quotient gives the term required. Example.

The rate is 2, the ſum 765 and the leaſt term 3. to finde the greateſt.

Multiply 765 by 1 to that product add 3 the ſum is 768, which divide by 2 the quotient is 384 the term ſought.

4. To finde any term of a Geometrical progreſſion, although all the intermediate terms be not known.

Continue on the progreſſion for 4 or 5 or more terms, and place Arithmetical terms over their heads, ſo will the lower numbers be in Geometrical, and the upper in Arithmetical proportion, then adde ſuch Arithmetical

terms together as will make the number of the Geometrical term required, (if it be greater than any given term) then multiply the Geometrical terms which were under the Arithmetical terms, and their product give the term required. Example.

The Rate of a progression is 3 the first term 2 to finde the 12th term: continue the progression as below.

1	2	3	4	5	6
2.	6.	18.	54.	162.	486

now because 6 and 6 makes 12, I multiply the term under 6, *viz.* 486 into its self the product, *viz.* 236196 gives the 12th term fought.

2 To finde the 34th term of that progression; because 5 and 5 makes 10, multiply the term under 5 into its self the product, *viz.* 26244 gives the 10th term which multiplied into itself gives the 20th term, *viz.* 16887.47536 which multiplied by the 10th term (because 20 and 10 makes 30) the product is the 30th term: lastly, this last product multiplied by the 4th term (because 30 and 4 makes 34) gives the 34th term fought: and thus any

any other term may be found.

But if a leſſer term be required then the given term, then ſubſtract the Arithmetical terms (that being added would make the number of the term required) and divide the Geometrical terms anſwering to them, the quotient gives your deſire.

Thus to finde the 4th term the 10th, and 6th terms being given, ſubſtract 6 from 10 the remainder is 4 divide the tenth Geometrical term by the 6th, the quotient gives the 4th ſought.

One bought a horſe after this manner, the horſe had 4 ſhoes, every ſhoe containing 6 nails, he thinking to have a good bargain was content to pay a farthing for the firſt nayl, and double it to the laſt, what ought he to pay for the horſe?

Here the Rate is 2, the firſt term 1 to finde the laſt term, and then (by the firſt head) the ſum of the terms: here the laſt term according to the directions given will be found thus: 4 and 5 make 9 therefore 16 (which is the 4th term) multiplied into 32 (the 5th term) gives the 9th term, *viz.* 512.

again 9 and 9 makes 18 therefore 512 multiplied by 512 gives 262144 the 18th term; again 18 and 5 makes 23, therefore 262144 multiplied by 32 gives the 23*d* or last term from the first term 1, *viz.* 8388608: by which the sum is found thus (as is already directed) 8388608 the last term multiplied by the Rate, *viz.* 2 is 16777216, from which 1 the first term being substracted, the remainder is 16777215 which divided by 2 less by 1, the quotient is the same 16777215 the sum required, which is 17466*l.* 3*d* 3*f.* a very great price for a horse.

I might here subjoyn other questions and problems concerning Geometrical progressions, and the finding of mean proportionals, but they being too abstruse for meaner capacities, and depending much upon the understanding of proportions, and extraction of roots, I shall omit them until a more fit time, but shall in the mean time refer the ingenious Reader to *Tacquets* Arithmetick; the 5th book *de Progressionibus*, where the properties and affections of progressions are plainly demonstrated.

CHAP.

CHAP. XXXVI.

The Extraction of the Square root.

A Square number is the product of a number multiplyed into its self, so 25, 64, 81 *&c.* are square numbers; for 5 times 5 is 25. 8 times 8 is 64. 9 times 9 is 81. The number which multiplied into its self, produces the square number is called the root, so 5 is the root of 25, 8 the root of 64, *&c.*

The root being given, the square of that root, may be found by multiplying the root into its self, for the product gives the square, so the square of 12 is 144, for 12 times 12 is 144.

The square number being given its root may be found according to the following directions, and this is called the Extraction of the square root.

First, its necessary that the learner have by heart this table of the squares of the 9 figures, *viz.*

Roots, 1. 2. 3. 4. 5. 6. 7. 8. 9.
Squares, 1. 4. 9. 16. 25. 36. 49. 64. 81.

When any square is given that is less than 100, take for the root of that

ſquare, the root of the ſquare number, that is next the leaſt, ſo the root of 92 is 9; for 81 is the next leaſt ſquare, whoſe root is 9. ſo the root of 45 is 6, *&c.*

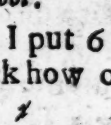
When the root of a ſquare is required, that is greater than 100, then write down the ſquare, and beginning with the figure next the right hand put a point over every other figure, thus if the root of 1024 be required the number will ſtand thus prepar'd for Extraction? 10·24·

Then draw a crooked line on the right hand for a quotient, which done, your ſquare will be divided into ſeveral parcels, thus, it conſiſts of 10· and 24· wherefore beginning with the firſt part, ſeek the greateſt ſquare number containd in it which (in the Example) is 9, wherefore write down 9 under the 10, and write the root of 9 *viz.* 3 in the quotient, which done ſubſtract 9 from 10 and write the remainder above 10, cancelling the figures as in diviſion.

```
9 viz. 3
1
~~1~~~~0~~24(3
~~9~~
```

Then double your quotient, and write the double under the following figure,

figure of the ſquare, thus, I put 6 under 2 as a diviſor, and ſeek how oft 6 is in 12. which found twice, I write 2 in the quotient and 2 under 4, the multiplying and ſubſtracting (as in diviſion) there remains 0, ſo that I conclude 32 is the root of 1024, which you may eaſily prove, by multiplying 32 into its ſelf, for the product is 1024.



Note, 1. that in ſeeking how oft your diviſor is containd in the dividend, you muſt conſider that whatever you put in your quotient, muſt be alſo written on the right hand of the diviſor as a part of it, wherefore you muſt have reſpect unto it (as in diviſion) and not take the diviſor, no more times than the dividend will allow, having reſpect to that following figure of the diviſor; thus in the Example, becauſe 2 held twice in 4 and took 6 twice in 12.

Note, 2. But if after you have doubled your quotient, and plac'd it down as a diviſor, the dividend be leſs than it, then muſt you remove it a place nearer the right hand, having

firſt

first put a Cipher in your quotient, and annexing a Cipher to the right hand of your divisor, then proceeding as before

Note, 3. That the work for finding out the first figure of the root is but once in the Extraction of the root of any number, consisting of what number of places soever; but the work for finding the second figure is to be repeated for finding all the following figures.

The practice of these notes will appear in the following Examples.

Example 1. to find the square root it will stand thus prepared, then seek the greatest square in 12 which is 9, place 9 under 12 and 3 in the quotient, then substract 9 from 12, rests 3, which write above 12, then double the quotient 3 it makes 6 which write under 3 the following figure of the square number, and seek how oft 6 in 33 you will finde it hold 5 times, wherefore write 5 in the quotient and on the right hand of 6, then multiply & subtract (as in division) and write the remainders orderly above their respective figures.

```
  3
~~12~~3468(3
  ~~9~~
```

Then, double all your quotient again,

gain, which makes 70 which place under the dividend (2
instead of a divisor 3 09 (67
and seek how oft 7 4 23 4 68 (351
in 9 which is once; 9 6 5 0 4
wherefore having 7
put 1 in the quotient, and under 8 in the dividend, Multiply and subtract (as in division) writing the remainder orderly as before, and this work is to be repeated so oft as there are figures of the root to be found.

Example 2. To extract the root of 365678
prepare it as before thus, 365678(

1. Seek the greatest square in 36, which is 36. place 36 under 36 and 6 in the quotient, then subtract 36 from 36 rests 0.

2. Double the quotient it is 12 which place orderly as in division thus,—— 0
but I finde 12 is 3 6 5 6 7 8 (6
not had once in 3 6 2
5 wherefore I 1
put a cipher in the quotient and remove the divisor a place further annexing thereto a cipher thus.

then

then I seek how oft 1 in 5 which I finde oniy 4 times, wherefore I put 4 in the quotient and under 8, and then multiplying and subtracting (as in division) the remainder is 862 and the extraction ended whence I conclude, that 604 is the root of 365678 very near.

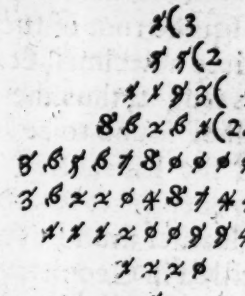
```
   0 862
365678( 604
362204
  11
```

To finde the fraction part of a Root.

When after extraction there remains any thing as in the last Example, then that shows there is a fraction in the root which may be thus found.

Adde to the square number pairs of ciphers, the more you adde the nearer you will finde the root, this done, continue on the extraction so long as you think fit through 2 3 or more pairs of ciphers, then see how many points are over the square number and cut off so many figures off the left hand of your quotient for the Integers, and the rest give the fraction, of the root.

See the following Example.



The root is 604.741 very near.

The proof.

Multiply the root into its ſelf, and to the product add the remainder of the extraction (if there be any) the ſum if equal to the ſquare given, the work is true.

To extract the ſquare root of a fraction.

Extract the ſquare root of the Numerator, and place that for a new Numerator, alſo extract the root of the denominator and place that for a new denominator, the new fraction gives the root ſought, thus the ſquare root of $\frac{2}{16}$ is $\frac{1}{4}$, and the ſquare root of $\frac{4}{25}$ is $\frac{2}{5}$.

When either the numerator or denominator of the fraction, hath not a perfect ſquare root, then preſix to it this ſigne v.

To

To find the ſquare root of ſuch a fraction, reduce it to a decimal, & extract the root, as is taught, thus the ſquare root of $\frac{13}{16}$ will be found to be, 9013.

The uſe of the Extraction of the ſquare root is very great but to exemplify it, the learner muſt be ſuppoſed ſomewhat skilled in Geometry, which being from the intent of this tractate, I ſhall omit it, and only ſubjoyn a few directions for meaſuring of hangings, pavements, or *&c.*

1. A ſquare ſuperficies is meaſured, by ſquaring one ſide, the product gives the ſuperficial content.

Example, a pavement 10 yds ſquare that is 10 in length, and 10 in breadth contains 100 yds ſquare, ſo every ſquare foot contains 144 ſquare inches.

2. A long ſquare is meaſured by multiplying the breadth into the length the product gives the ſuperficial content, thus if a piece of Arras hanggings be 10 yds long and 4 yds broad, it will contain 40 yds ſquare.

Likewiſe a field 50 poles broad, and 60 poles long, will contain 3000 poles ſquare.

3. A

3. A Triangle is measured by multiplying the length of the perpendicular, (let fall from one of the Angles upon one of the sides) into ½ the length of that side upon which it falls, or by multiplying that side into ½ of the perpendicular.

Example. If in a triangular field one side be 80 pole and the perpendicular that falls on that side be 40 poles, then will the content of that field be 1600 poles.

4. A circle is measured by multiplying ½ the circumference by the semidiamiter. So if the circumference be 25 the semidiamiter 4 the content is 50.

The proportion for finding the circumference is; As 7 to 22 so is the diameter to the circumference; or as 22 to 7 so the circumference to the diamiter.

This is only a short account of th measuration of *superficies*, the demonstration of these precepts and of the rules already delivered in this tractate, would require a good knowledge of Geometry, which perhaps I may in short time exhibit in print for publick good; in the mean, time what is here delivered take in good part, use it and enjoy it,

FINIS.

Poſt-ſcript.

BY reaſon of the Authors abſence from the Preſs, and the badneſs of the Copy, ſome Errata's have eſcaped, which are not unuſual in Books of this Nature, but the Rules and Method are exact, The Intelligent Reader is deſired to amend ſuch with his pen as he ſhall meet with, the Author promiſing he will take care to have all corrected and amended exactly in the next Edition.